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ABSTRACT

The present document presents a review of the proceedings of a workshop held in May 1971 on "Teaching University Biological Sciences." The major papers dealt with in the report are: (1) "Application of the Systems Approach to Teaching and Learning"; (2) "Biology and Social Change"; (3) "Biology for Biology Majors"; (4) "Design of a Short Instructional Unit"; and (5) "Pursuing the Objectives of Independent Study." The Council of Ontario Universities, under whose auspices the conference was held, had a keen interest in the conference for several reasons. Results elsewhere in the world have suggested that course team approaches to curricular development hold considerable promise for improving the quality of undergraduate education. The evidence suggests, also, that although developmental costs are high, there may be financial savings in the long run. (HS)

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FRONTIERS IN COURSE DEVELOPMENT: SYSTEM AND COLLABORATION IN UNIVERSITY TEACHING

Report of the Conference on Teaching University Biological Sciences, Jacksons Point, Ontario

MAY, 1971

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May, 1971

With a keynote address by David G. Hawkridge, from the Open University and contributions by W. H. Dowdeswell, Bath University, R. H. Haynes, York University and J. L. Southin, McGill University

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* Items marked thus are contributed papers with wide relevance to university teaching.

FOREWORD

In 1970 the Council of Ontario Universities and the Committee on University Affairs jointly commissioned a study of Television and Technology in University Teaching. The resultant report prepared by Bernard Trotter had among its recommendations a proposal that funds be provided for any inter-university discipline group wishing to explore the course team approach to university teaching. One such proposal from the biologists in Ontario universities has been funded and this report gives an account of what took place. The conference on the teaching of University Biological Sciences was held in May, 1971 at Jackson's Point, Ontario. It lasted four days and was attended by some 100 teachers of Biology.

The Council of Ontario Universities had a keen interest in the conference for several reasons. Results elsewhere in the world, most notably in conjunction with the Open University in the United Kingdom have suggested that course team approaches to curricular development held considerable promise for improving the quality of undergraduate education. The evidence suggests also that although developmental costs are high there may be financial savings in the longer run. In addition, the conference represented Ontario's first real venture into an inter-university approach to curriculum and was likely therefore to provide guidance on how to proceed (and perhaps how <u>not</u> to proceed) in this new form of cooperation.

The organizers of the conference undertook to provide a full account of the proceedings as a helpful guide to representatives of other disciplines wishing to explore course team opportunities in their own fields of study. The conference organizers have fully met that commitment in the following candid account of their stimulating and productive four day meeting.

The Joint CUA/COU Steering Committee on Educational Technology has now recommended to the Committee on University Affairs that modest sums be made available for partial support of additional conferences in other disciplines, subject to submission of reasonable proposals.

The Council of Ontario Universities believes that attractive possibilities lie in the pursuit of cooperative curriculum development and hopes that on the basis of the following report, a number of groups in Ontario will be encouraged to proceed with their own experimentation.

January, 1972

J. B. McDonald,
Executive Director,
Council of Ontario Universities.

PREFACE

It is the purpose of this report to share with other members of the university community in Ontario the learning experience of the hundred or so who participated in the Workshop Conference on Teaching University Biological Sciences (TUBS) in May, 1971.

Why is this experience worth sharing and why might it be worth the attention of busy academics? This report claims attention because it deals with matters affecting the essence of what a university teacher is paid, in the main, to do. It deals with teaching. It deserves attention especially from three groups: those professors who are most skeptical of the existence of new and worthwhile ideas about teaching; those concerned with possible advantages of inter-university cooperation; and those interested in methods of group training in teaching for university professors. For the most skeptical, the report may only reinforce their attitudes but for most it will encourage at the very least a stock-taking and a thinking through of practice and beliefs about the whole teaching process.

This re-thinking is what happened for most of the persons who attended the conference and it is the intention of the editors to present information about the origins of the conference, its planning and preparation, its actual outcomes so far as these can be assessed, and its potential outcomes given the possibility of follow-up action of various kinds, so that those who read the report or selected parts of it will share the conference experience to some degree and benefit from it.

The TUBS conference is unique in the Ontario experience. Never before have teachers from all universities come together to discuss problems of teaching one discipline in an organized and systematic way. The workshop, as the detail of the report will make clear, was a concentrated program of study in the systems approach to course design and

development at the university level. As such, its achievements and failures have relevance for all who are concerned with improving university teaching and who are interested in practical ways of doing this.

Although the conference dealt nominally with the teaching of biology, representatives of related, or in some cases quite different, disciplines were present and although the discussion used biology courses as examples, this report is not technical. Indeed, most of the discussions can be followed without special knowledge of biology. Those who are not biologists, or who are concerned only with the general implications of the conference, may choose to go lightly over the presentation of the work of specific workshops in section 4.

The report follows a generally chronological plan. The introductory section explains the background and origins of the conference and describes the planning and preparation including that part of the first plenary session which could be considered introductory to the main work of the conference. The detail given in this section emphasizes the role of the conference workshop as a structured program of study and not a random happening. The next section gives the keynote address. This is followed by accounts of the workshop group sessions which include, in abbreviated form, the opening presentations of invited experts, the reports from the workshop groups and the evaluations of the workshops by both the group leaders and the editors.

The fifth section of the report contains the evaluation of the conference by Dr. Hawkridge, and then the reflections of the editors on the conference from the first proposal to the writing of this report. These reflections bear on a series of questions which the editors believe to be important for university education and to have been illuminated by the TUBS conference. The questions are:

1. Do most university teachers need help in recognizing and meeting problems of teaching?

2. How many university teachers would like help in improving their teaching?

3. What would be the most satisfactory and economical ways of offering help?

4. Has the systems approach much to offer to university teaching?

5. Is a collaborative approach to systematic course design productive?

6. Does the systems approach imply inter-university cooperation?

7. Does the systems approach hold hope of changing the pattern of teaching so that university teachers can use their time for both teaching and research more efficiently?

8. What implications for the future development of existing universities in Ontario would there be in a radical reorganization and reordering of the instructional process based on a systems approach?

We return to the first seven of these questions in our evaluation of the conference and to the eighth in a postscript by one of the editors. The evaluation section ends with a statement of conclusions and recommendations aimed at exploiting the momentum towards better teaching and better use of resources which the editors think the TUBS conference has generated.

The editors would like to acknowledge the help which made the conference possible. Planning, implementation of plans, and the conference itself covered a period of barely four months. This was only possible because of the unstinted efforts of the coordinator, Mrs. Jeri Harmsen. The conference depended also on the support of the Chairmen of Biology and on the Joint Steering Committee of the Study of Educational Technology of the Committee on University Affairs and the Council of Ontario Universities. Three participating universities provided assistance during the conference in the form of secretaries and office equipment. The diligence and cheerfulness of the secretaries is gratefully acknowledged as is the advice and assistance in planning provided by Mario Creet of the Queen's University Office of Academic Planning.

BACKGROUND, PLANNING AND PREPARATION

Background

For the past four or five years the Ontario universities have been encouraging the development of inter-university committees representing the major disciplines. During this time the universities have also been interested in the application of technology to university teaching. The TUBS conference had its origin in a fusion of these two lines of interest.

The major objective in encouraging inter-university committees in each discipline has been to give a basis for rationalizing specialist and graduate programs. The committee of biologists is one of the few to have instituted cooperation at the undergraduate level. Progress has been most evident in rationalizing summer school offerings and coordinating programs at various field stations.

Two years ago the biologists first explored the possibility of a cooperative first year course based on jointly produced televised material. Although this did not materialize, it illustrated a strong interest in teaching methods derived in part from the rapidly changing nature of the discipline. In most courses biological theory is rapidly increasing at the expense of factual content. Moreover, the newer technologies such as television are, for all their manifest problems, peculiarly suited to the life sciences where information so often must be presented in visual form. University teachers of biology have indeed been making extensive use of television, audio tutorial systems, tape-slide combinations and the whole gamut of techniques for presenting educational material. This has been especially true for large first year classes. It was therefore not surprising that in October 1970, the Committee of Heads of Departments of the Biological Sciences (CHUBS) proposed that earlier cooperative activities be extended and a meeting of teachers in first year courses in biology be convened to exchange ideas and experiences in designing and presenting first level courses in biology.

This proposal for a conference of biology teachers was made just as a report entitled Television and Technology in University Teaching by Bernard Trotter was in the final stages of publication. A major premise of the report was stated thus: "The over-riding imperative of technology is system. Any discussion of educational technology must therefore be about the systematization of the educational process". In suggesting that discipline groups might be the most effective avenue of approach to systematization Trotter had in mind the example being set by the biologists in seeking collective solutions to teaching problems.

Accordingly while the objectives as set out by the Committee of Heads were retained, new objectives for a more ambitious meeting were added to provide for a general study of the systems approach. Support for the more ambitious conference was sought and obtained by CHUBS from the Joint Steering Committee of the Council of Ontario Universities and the Ontario Committee of University Affairs which had sponsored the Trotter study.

Thus, the proposal of mid-October matured, in little more than two months, into a proposal to hold a Workshop Conference on Teaching Biological Sciences which was intended to be a training ground for university teachers, a trial of the systems approach to course design and a possible prototype for similar conferences involving other disciplines.

We have used the terms "educational technology" and "systems approach" above and will want to use them again. The senses in which they are used should therefore be more explicit. In a recent report Hilary Perraton, Director of the Inter-University Research Unit, Cambridge, says "It is unfortunate that the relatively new term 'educational technology' is already used in two senses: to cover the development of systematic processes in education and the application to it of communications technology". These senses are not so much distinct as complementary parts of the whole. In North America, however, "educational technology" has inescapable hardware connotations. We have therefore tended to refer instead to a systems or systematic approach when discussing the overall course development process. As we use the term "systems approach" it covers both software and hardware prescribed by the program, but implies far more emphasis on the former. Essentially, the systems approach attempts to consider <u>all</u> the component parts of a process, the critical enunciation of objectives, the priorities assigned to them and the design of strategies to achieve these objectives by the most efficient means.

The systems approach has been used in many contexts over the past three decades. It had its birth in wartime as operations research. Later designations included systems analysis, critical path planning, etc. It is ironic that a university which would not let out a contract for a new building unless the contractor used critical path planning should never have invited its staff to apply the same principles of planning to the teaching/learning process. Admittedly the what, how, and who of teaching have been traditionally, and on the whole rightly, the autonomous preserve of the faculty. And all would agree that designing and presenting a course is a different kind of activity altogether from designing and constructing a building. Nevertheless, if the instructional activities of universities bear improvement - and there seems to be universal agreement that they do - the principles of the systems approach at least deserve examination for the guidance they may offer. Of course the systems approach is a process not a product. It offers means not ends. It is no panacea. It does not provide ready-made answers but only a procedure by which answers which are correct, or at least sensible, can be achieved. It is essentially a device to compel the logical pursuit of objectives and to prevent the omission of relevant considerations. No more and no less.

Planning and Preparation

The combined planning and preparation for the conference was compressed into a scant four months. Very early in 1971, the Committee of Heads of Biological Science Departments named a Planning Committee which was approved by the Joint COU-CUA Steering Committee. This committee met January 11 and appointed Mrs. Jeri Harmsen to work directly with the Chairman as principal conference coordinator.

At that meeting of January 11, the Planning Committee chose May 16-20 as the preferred time, and decided on the general format of the conference, i.e. as a workshop conference with three concurrent groups of workshops each involved with a distinct problem as follows: Workshop 1. to design a course called "Biology for Everyman", Workshop 2. to design a first year course for students intending to become professionals in one of the life sciences, and Workshop 3. to design a short section of a course (a module or mini-course) on a limited topic to be chosen by the participants. It was also decided to have one keynote speaker who would initially be able to introduce and review the systems approach to course design and then to act as a consultant to the workshops for the remainder of the conference. It was agreed that there should be a leader for each workshop who would be familiar with the assignment that workshop was tackling and would also be experienced to some extent with the systems approach. Finally the "staff" of the conference was to include a chairman for each group who would be carefully selected and would have some training for the assignment. With three workshops, each divided into three groups of about 10, the conference size was set at approximately 100 (90 plus ancillary personnel).

The planning committee chose to hold the conference away from any university. The rationale for this was that a small summer hotel could provide a pleasant spring environment and complete seclusion from office routines. The aim was "total immersion" in the conference. The Briars Inn and Country Club was selected only after the coordinator had reviewed half a dozen possibilities and had visited the Briars to plan every detail of accommodation for delegates, for groups, for workshop and plenary sessions, and for meals and social periods. This careful selection and arrangement of accommodation resulted in an excellent match between accommodation and activities.

The committee met again on February 14 and 15 to hear reports on progress, to select chairmen, to approve the allocation of places for delegates and the procedures for

delegate selection, and to tackle one of the workshop assignments (Biology for Everyman) as an experiment in order to get a feeling for how the work would go and how much time would be required. The conference plan shown in Figure 1 and prepared by Jeri Harmsen and Mario Creet was approved. On the basis of the decisions of this meeting the chairman wrote letters to those selected as conference speakers or workshop leaders. With help from the British Council and AUCC, the British mail strike was circumvented and the letters and replies received in time to meet the pressing deadlines. The letters requesting selection of delegates were also approved.

The general formula for issuing invitations to name delegates was to provide for the Head or Chairman, plus three staff members and one student from each Biology Department. In addition, each university was invited to name two delegates from other disciplines. The numbers of delegates were, however, adjusted somewhat in relation to the size of institution and the number of departments involved. At a later stage when it was clear that some of the universities would not be sending a full complement, a few places were allocated to universities who wanted to send additional delegates. Selection of delegates was done through the office of the president of each university. The letter initiating this was issued February 18th. The suggested procedure for selection is outlined in Figure 2.

FIGURE 2: Proposed Procedure for Selection of Delegates for Workshop Conference on Teaching University Biological Sciences

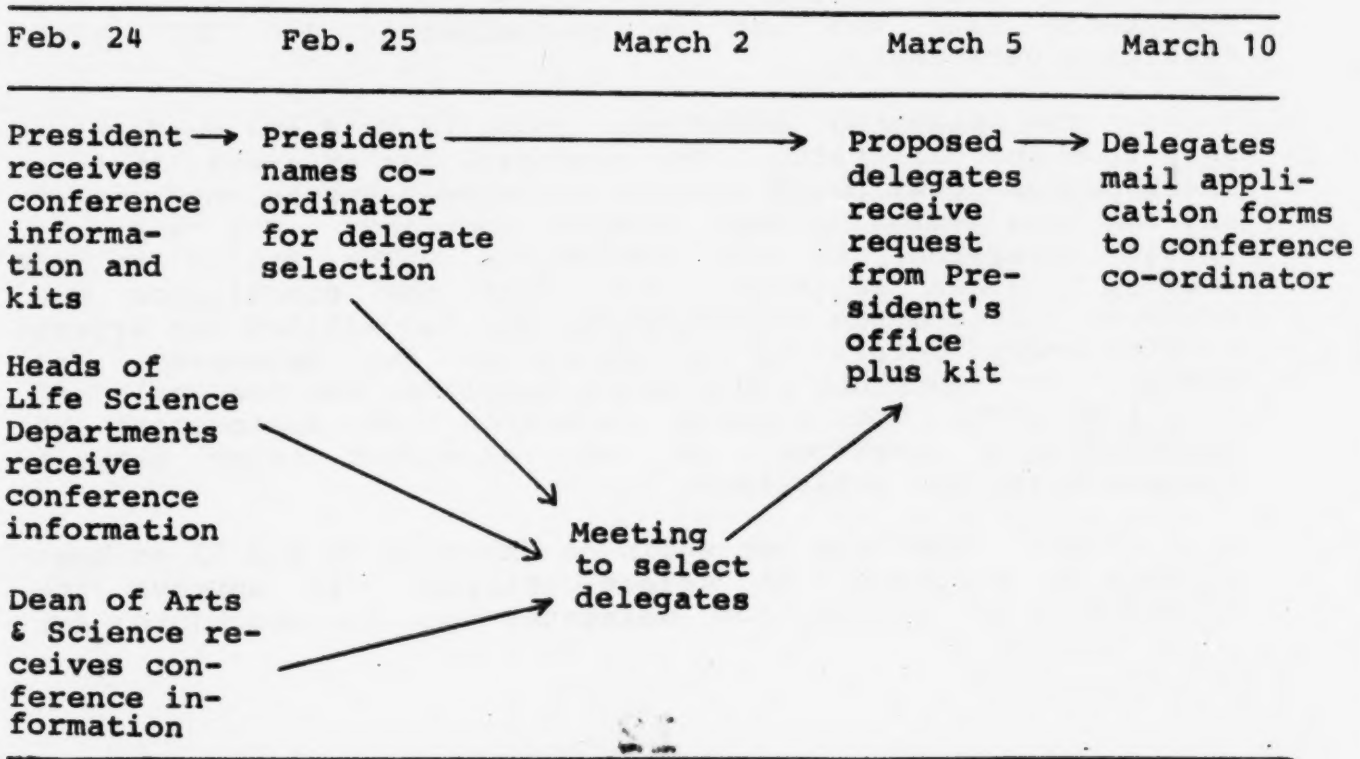
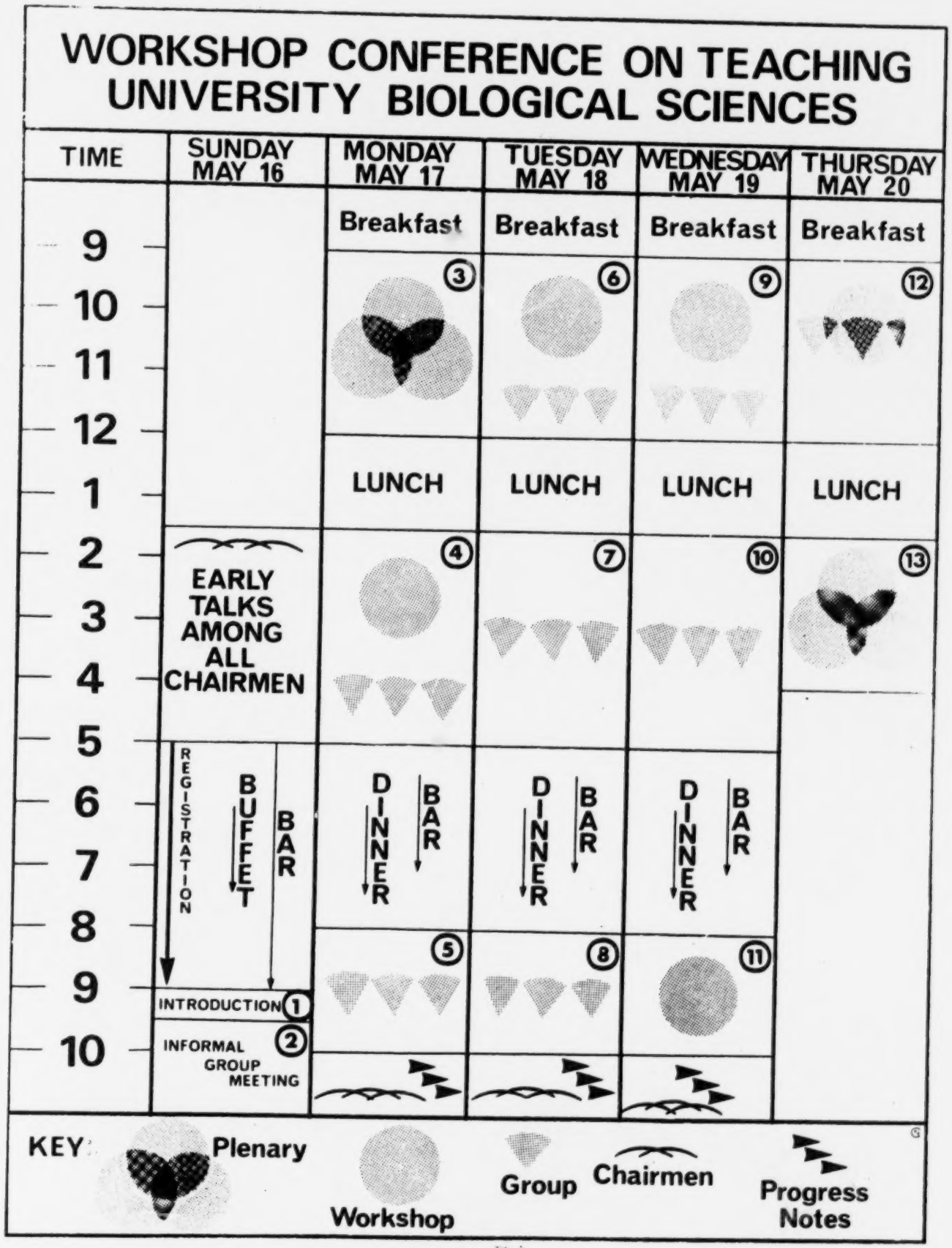

Feb. 24
Feb. 25
March 2
March 5
March 10
President receives conference information and kits
President names co-ordinator for delegate selection
Proposed delegates receive request from President's office plus kit
Delegates mail application forms to conference co-ordinator
Heads of Life Science Departments receive conference information
Dean of Arts & Science receives conference information
Meeting to select delegates

FIGURE 1: A diagrammatic representation of the organization of the TUBS Conference.



A limited number of places was reserved for representatives of the joint CUA-COU steering committee, the Commission on Undergraduate Education in the Biological Sciences in Washington (CUEBS), the Mini-course Development Institute at Purdue, etc. In general invitations were sent only to those with which the Planning Committee had had contact during the early stages of its hurried preparations. In the haste implied by the very tight schedule a number of bodies which would have been able to contribute valuable representation were regrettably not included.

About a month before the conference, delegates were sent reading material on systematic course design. This was based largely on Part III of the book Teaching and Learning - An Introduction to New Methods and Resources in Higher Education by Mackenzie, Eraut and Jones (1970). A modified and more detailed schematic diagram of this approach was prepared by Mario Creet and distributed to delegates (see Appendix II).

Each delegate was asked to fill in the usual type of registration form indicating his preference in workshops. He was also asked to prepare a one page position paper on some topic related to the subject of course development. It was hoped that these position papers would stimulate thinking prior to the conference, would allow delegates a pre-conference input, and would provide some good material for distribution to other delegates.

On April 12 and 13 a meeting of the group chairmen was held in the Department of Zoology, University of Toronto. At this meeting the structure of the conference and the role of the chairmen was reviewed and the topic of Workshop 2 was chosen for another trial run at the procedures proposed for the conference.

The chairmen met again on the afternoon preceding registration at the conference and once more reviewed their approach with help this time from Dr. Hawkridge. The role of the group chairmen as rapporteurs and the nature of the notes on developments in their groups which they were asked to prepare each day was discussed. The question of evaluation of the conference was also discussed. It was agreed by those present, including Dr. Hawkridge and Mr. Dowdeswell, that an elaborate quantitative evaluation was not feasible. A simple, if somewhat subjective, analysis of comments by the consultants and by the members of the planning committee seemed likely to be as valuable as a badly done objective evaluation. It was also agreed that the notes on each session would be prepared by the group chairmen as a record of

progress but would not be issued as interim reports to the whole conference on a daily basis.

The final stage of preparation for the real work of the conference might be considered to be the introductory part of the first plenary session which is, accordingly, dealt with here.

At the beginning of the plenary session on Monday the Chairman referred briefly to the origins of the conference and discussed its objectives in relation to the systems approach to course planning and to inter-university cooperation which, he argued, were to a considerable extent interdependent. His remarks, in summary form, follow:

"The only reason for developing inter-university cooperation is the assumption that there are some things which a group of universities can do better than can one university. Cooperation can only develop after there has been close agreement on objectives and definition of objectives is the first stage of a systematic approach to teaching. The systems approach can therefore clearly assist in the rational development of cooperation between universities.

Cooperation can also materially assist in proper development of a systems approach. The systematic development of educational programs as suggested by Messrs. Perraton, Trotter, MacKenzie and others, is not simply and quickly done. It requires a very heavy investment of time. This can often only be justified when a relatively large audience is involved. A cooperative approach by several universities is clearly one way of getting such a large audience. It can therefore be argued that system is needed for cooperation, and cooperation is frequently needed for development of system. Although this proposition may not be generally accepted, I believe that it is central to the purpose and organization of this conference.

This leads me to propose that the conference has three objectives. The first is a very general one - to examine the proposition that system and cooperation are indeed interdependent. The second is more specific. It is to provide a training ground in systematic course development with assistance from acknowledged experts. This training will then be applicable to our own teaching. Finally, there is the relatively specific objective of developing courses or units of courses. If the conference reaches this final objective, it may wish to propose some formal mechan-

ism for cooperative production of course materials. Such a mechanism might involve setting up smaller follow-up study groups to carry the work forward.

These objectives have been defined so that we cannot fail in all. Neither, to be realistic, are we likely to achieve all. The Planning Committee chose to organize the conference around specific projects because it felt that this would favour success in reaching both the more general and the more specific objectives but we should not stress the importance of completing the design of any course or instructional unit. In trial runs with the Planning Committee and the group chairmen it became clear that the conference is too brief to expect completion of the projects. To press for completion might be to preclude the repeated examination of the course and its objectives, and to fail in the primary purposes of the conference by striving too hard for secondary ones. However, Workshop 3 which is restricted to a short module rather than a whole course, has a reasonable chance of completing a design.

Because the objectives of the conference are primarily to explore the method, and only secondarily to produce specific courses, it seemed appropriate to invite participation by teachers of subjects other than biology. I am sure that they will be able to contribute a great deal, especially by challenging those of us who are biologists to explain why we are taking a certain viewpoint and perhaps revealing to us that tradition rather than reason is in control. In any case, we welcome these representatives of other disciplines and hope their time at the conference will be rewarding. The conference has, we hope, been adequately structured and organized without being over-organized. There is no intention to stifle originality within the groups. Biologists hardly need reminding that quite different strategies can be evolved to cope adequately with the same problem."

The chairman then invited Dr. David Hawkridge to initiate the main work of the conference by presenting his "keynote" address which forms the following section of this report.

KEYNOTE ADDRESS

Application of the Systems Approach to Teaching & Learning

David G. Hawkridge
Professor of Applied Educational Sciences
Director - Institute of Educational Technology
The Open University
Walton, U.K.

Straight away I would like to thank the Steering Committee for their invitation to Briars Inn. This is a delightful place to work in and I feel privileged to be here.

The fact that this workshop has been arranged - and that it has attracted such support - must indicate considerable interest in both subject matter and teaching techniques among the Biology Departments of eastern Canadian universities. I am going to assume from the start that all of us here are interested in the ways of teaching the biological sciences at university level, and that the chief foci of interest for this workshop are on both these teaching techniques and the subject matter.

When the Steering Committee invited me, I hope they were under no illusions about my knowledge of the biological sciences. I am not a biological scientist. On the other hand I am greatly interested in teaching techniques. For me, course development is a process by which teaching techniques for a particular set of subject matter can be refined. This process turns out to be an unexpectedly complicated one, as we shall see from the examples that I shall quote from the Open University.

Keynote speakers are supposed to sound the keynote, I understand, and I want to do that right now. The keynote for this Conference is that co-operation is good for course development. In the case of this Conference it is co-operation between university Biology Departments. I suggest,

moreover, that co-operation is not only good for course development - it is vital. The days are fast disappearing in which the university community could afford to split itself into many small, competing ivory towers. If the quality and quantity of available courses are to keep pace with accelerating demand, co-operation in course development is essential. The tasks are too massive to be undertaken by small groups with limited resources. But Good (1971) has dealt with this topic in his brief to the Ontario Commission on Post-Secondary Education.

What is course development? In thinking about this paper, I considered a number of theoretical models that have been put forward, such as the network analysis schemes of Platts and Wyant (1969), the curriculum process analysis developed in Sweden by Dahllof and Lundgren, Morrissett and Stevens' (1967) steps in curriculum analysis, Dyer's (1969) broad systems approach, and very recently, Schmidbauer's (1971) paper on the development and planning of multi-media instructional systems. Needless to say I also examined again the book by MacKenzie and his colleagues (1970). As I thought too about the audience that would be assembled here, I decided against putting before you a vast theoretical model which you would then have to translate for your own needs. If you want a fairly simple one, Schmidbauer (1971) has one, but I want to tell you instead about applications, in the hope that these will be of more practical value to you. In other words, course development will be what I am talking about, the actual process of designing and implementing a complete instructional system.

This is what I plan to do during the course of this paper. First of all, I shall deal briefly with what Norman McKenzie and his colleagues have had to say about course development in their book, from which many of you have had the chance to read the relevant chapter. Then I shall go on to consider the Supplement issued by the Steering Committee for this workshop. But I should say now, that I do not expect to use either of these documents as the basis for what is the main part of this paper.

Next, I shall outline to you the course development techniques being used at the Open University. I do not want to spend too much time on them, but I think that many of them are relevant to our present situation.

Soon after the half-way mark in this hour that we have, I expect to begin to put forward to you some general propositions about course development, and to try to relate these to what you plan to do during the next few days.

MacKenzie on Course Development

Since you were all asked to read before this workshop Chapter XI from the book by MacKenzie and his colleagues, Teaching and Learning, you will know that this chapter is a very brief introduction to some ideas about course development. It may have made perfect sense to some of you. Others may have been put off by the jargon. Still others may have felt that it did not go far enough. But before we go further, let me summarise the main points. Eraut, who actually wrote this chapter, is saying that course development can and should be tackled systematically, and that a course development team working together in a systematic way will come up with a far better product than several individuals working on their own. His view is supported by evidence from a number of institutions, he says. The first half of the chapter, the part that concerns us, considers a course as a system in which students, teachers and learning materials interact, and examines some of the constraints on the system. Parts of the system that are identified include the student input, the instructional input, the course development process, the intended outcomes and their measures, and the feedback or evaluation through which the prototype course is improved.

A little is said about each of these items, but not enough to form the basis for action by a group like this. I shall come back to some of the terms that have been used, as they are quite suitable descriptors of some essential parts of the system. But for the moment, I suggest that we do no more than agree that Eraut has put forward a general plan for us. In particular, we should accept his suggestion that far too little is known about teaching and learning, therefore in course development it is best to design a prototype and try it out, using a test-and-revise cycle of operations.

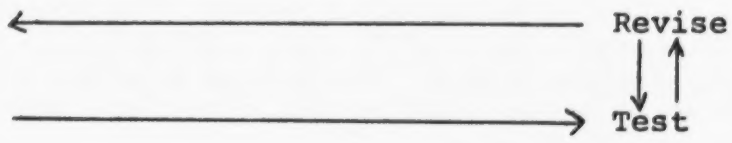
Supplement From Steering Committee

If we turn now to the Supplement to Chapter XI*, prepared for the Steering Committee, some of the inadequacies of the chapter are underlined, and some diagrams and notes are presented to help us take our ideas a little further towards being practical.

I was glad to see that the iterative nature of activities in course development is emphasized again, and in my view this point cannot be emphasized enough. No matter what kind of chart we may come up with to show various stages of course development, we should bear in mind all the time the basic cycle of all research and development activities.

* See Appendix II

Figure 1. The Basic Cycle of Research and Development Activities



The Supplement identifies five main stages:

Preliminary - clarification of objectives
Stage I - initial brief
Stage II - model version
Stage III - prototype version
Stage IV - full course

The Supplement makes some suggestions about what may be included at each stage. For example, during the preliminary stage objectives should be clarified by both the teacher and learner. In Stage I the characteristics of the teacher and learner and the costs should be calculated and so on.

The flow charts that were developed to go with the Supplement will probably be quite useful during some of your sessions. In my opinion, based on our Open University experience, you may find yourselves unable to follow the exact sequence proposed in the charts, but that does not mean to say that each of the steps should not be gone through.

Open University Course Development

The Open University is just emerging from eighteen months of traumatic course development activities by the first four Foundation Course teams. Some six months ago it also plunged into the plethora of activities for the development of some twenty further courses. Now the Open University model may not be the exact one for you to follow, since it incorporates television and radio components as well as the more usual forms of printed exposition, but I believe there is much to be learned from what we have been through.

Before trying to give you some impression of the course development process used by the Open University, let me state some general principles we have learned.

First, the course team's vision must become as broad as is humanly possible. Breadth of vision in this case means trying to take into account all the factors likely to enhance the effectiveness of the course. This vision may be broadened by including not only subject-matter experts (the biochemists and so on) but also people who will pay attention to the functioning of the course within the entire system. Breadth of vision will mean breadth of debate and inquiry but these can only be ignored at one's peril.

Second, course teams always start out with some false expectations. No matter how quickly initial agreement is secured on content outlines or chapter headings, the laws of social dynamics apply. The whole business takes longer and turns out to be more complicated than the team had thought it would.

Third, the first version of the course to be published acquires a cultural stability, so to speak, a permanence, quite unrelated to its quality. What was thought of by the course team as a prototype suddenly calcifies as the version, in demand elsewhere and saleable.

At the Open University there are three main phases in developing a course: planning, writing and testing, and production. Since each of these is broken down into sub-phases, let me deal with each sub-phase in turn, without going into too much detail.

Phase 1a: Course Planning

Before the Senate can approve the establishment of a course team, information about courses needed has to be collated and analysed. The amount of information available has varied immensely, from studies by the Faculty of Technology of the requirements of industry and the professional accreditation bodies to the more general assumptions by the Faculty of Social Sciences about the likely needs and interests of its students. There must also be a review at this stage of staff talent and inclinations, although some flexibility is permitted through the provision of funds for hiring consultants in certain areas in which Open University staff are not available.

Once Senate and various other bodies within the University have approved the course and its team, information has to be collated and analysed about the characteristics of the learners, too. Data from the application forms of students are used in the case of foundation courses, while higher level courses will not only use these data but will

also assume that their students have acquired the skills and knowledge taught in certain earlier courses that are recommended as prerequisites.

A set of budgetary constraints have been worked out for each course team now. These were not available during the foundation course development cycle, but were forged through hard experience in encountering the costs of copyrights, printing, television production, and so on.

One of the earliest steps taken by the course team is to review books available. This is because orders have to be placed with publishers one year before they are needed by students, to ensure that adequate supplies are available. Obviously the choice of books determines to some extent the content of the course, therefore the choosing has to be done more or less at the same time as the selection of the broad areas and tentative title for the course. Simultaneously, a two to three page summary of the course has to be prepared for the University prospectus, which goes to print more than a year before the start of the year to which it applies!

In cases where an interdisciplinary or an interfaculty course is to be prepared, there has to be an early review of the balance within the course, and how this relates to the manpower being supplied for the work from each discipline or faculty.

Probably the best courses at the Open University have been produced by those course teams which tried to do a great deal of planning before any individual authors began writing or broadcasts were prepared. There is no doubt at all that the urge to start writing should be suppressed for as long as possible in favour of thinking and planning. If the course team tries to draw up a conceptual model of the course this model has the effect of improving communication between members of the team, and individuals are much clearer about what other individuals are expecting to do. What is a conceptual model? A model showing the concepts within the course and their interrelationships. Let me say a few words about such models.

First, as everyone who has been involved in curriculum development knows, there are many different levels of concepts. At this early stage, only macro-concepts can be talked about. These macro-concepts are given labels which are really quite inadequate as descriptors. Take the label COURSE, for example. That covers so many different concepts.

Second, the interrelationships between concepts are extremely complicated once you start analysing them. We often assume that there is a latent hierarchical structure to many subject matters, that there is a logical sequence in which they should be learned. If these assumptions were correct, the conceptual model would be fairly simple to draw up. Instead, the Open University people who have worked on these models suggest a nodal arrangement. Thus, the model may look more like a network than a logical tree, and there may be many points of entry.

The process of building a conceptual model of the course can be a painful one too, as individual course team members seek to establish their own territory. Once the model is completed, there may be last-minute revision of the prospectus entry before it goes to press, because people have changed their minds.

The model yields a list of units and blocks of units which can then be assigned to authors and working groups of authors, respectively. A block would cover associated topics, of course, and the working group would be made up of the several authors responsible for the block, plus in some cases other interested staff.

Once the work has been mapped out in this broad fashion, the time element can be taken into account too. The run-in time for a full 36-unit course is 15 to 18 months from the first meeting of the team to the first broadcast date, which is also the date by which the first unit must have been in the students' hands for at least a week. Most of the course teams have drawn up intricate schedules - and then had great difficulty in keeping to them! Some of their problems have been described by one of my colleagues (Lewis, 1971), so I shall not go into detail on this point.

Phase 1b: Unit Planning

You may have noticed that I have not mentioned the word objectives yet. Surely, you say, it is as well to write the course objectives during Phase 1a. You may be right, but the fact is that most of the Open University course teams have found it simpler to write them much later, when the course has taken some form, and some of the units have been produced. The same applies to course unit objectives, as I shall now explain.

During the past decade or more there has been much preaching about behavioral objectives. And a good deal of argument about how useful they are, both to teacher and to

student. Those of you who have tried to prepare sets of them will know that it is difficult to arrive at an optimum level of specificity and that there are some academic skills to be taught that are hard to describe in observable terms. Markle (1968) has shown that objectives are not in fact very good controllers of writing behaviour, and that test items are far better controllers. Of course, academics are not used to writing down first the questions that they want to have answered by their students at the end of the course or unit, and many Open University staff have not yet got into the habit, to say the least. Instead, they tend to produce short drafts of what they plan to put into their units. Because these are very tentative, in a kind of shorthand, other course team members do not criticise them enough really, and there is the tendency to hope that something clearer will come along in the second draft. Meantime the authors' ideas are crystallising, however, and as production proceeds it gets more and more difficult to introduce changes. This is why I was emphasising planning before writing.

At the unit planning stage, ideally, there should be tentative decisions about what, in the Open University system, should go on television and radio, what should go into home experimental kits, what into special handbooks, and what must be left until summer school. I wish we could say that we were already operating such an ideal planning system.

The learning materials for Open University students come in a number of forms. The basic units are supplemented by set books and recommended books available through normal publishing channels, and also by anthologies of reprints and similar items specially published by or for the University. During unit planning, many decisions have to be taken about these anthologies and their contents, and copyright has to be cleared.

For some units, extra material may be prepared to try to allow for the varied backgrounds of students, some of whom will need remedial sections and others of whom will appreciate enrichment sections that delve deeper into the basic subject-matter. The foundation course in science is a good example of this arrangement.

As soon as the authors have prepared first outlines of their units, these can be submitted to the working group. The group may ask for revisions, minor or major. Some authors may take the group's comments more seriously than others, but the draft, revised or not, will go to the course team next. If the course team does not like the draft, it can ask the author to revise it or even to redraft it completely. There have

been cases of authors redrafting several times before the course team was satisfied. Here it is a matter of teaching in public, as it were. But still the authors are no further than their planning draft. The first full draft comes in the next phase.

Phase 2a: Unit Writing

Before going on to the first full draft, the author will probably review, extend and amend his list of key questions, the table of contents, or the objectives, if he has these. If something has to be provided to go with his unit in the University's 284 study centres he will have to put up a strong case, now. He should begin to think about activities for the class tutors in those centres too, although much of the tutors' time will be taken up by students' problems. He will be enlisting the help of the television and radio producers now, if he had not before. In turn, the producers will be helping the course team to select the best presenters from among the academics.

The first full draft of the correspondence unit should be accompanied by an assessment emphasis matrix. This is simply a chart showing the level of objective measured by each of the various types of questions and test items going with the unit. It usually reveals that the majority of the items fall at the lowest level, that of simple recall. The author may then be persuaded that he should change some of them, and this in turn influences the content of his unit. Matters of copyright clearance and graphics have to be attended to in this phase as well, because of the long lead time required.

The first full draft runs the gauntlet of both working group and course team, just as the rough outline did. Since this will be the first occasion on which the full content has been revealed, the author may come in for heavy criticism, from his peers.

Phase 2b: Developmental Testing

Criticism from your peers is quite tough to take, but you can always claim to be more expert than most of them, in your chosen field. When a group of learners say they find it hard to learn from your learning materials, amendments are almost inescapable though. Developmental testing at the Open University involves sending the written materials to a group of learners (who are paid a small fee for their help). Ideally, they should receive everything that goes with the written unit: the television and radio programmes, the reading lists, and so on. In practice, the basic unit has

been sent by itself in most cases; this is not as unscientific as it sounds, because the integration between the basic unit and the other items is not very close.

The learners comment on each section of the units, and are usually sent a questionnaire which asks them about how long they took, which portions they found interesting or difficult and whether reading the unit increased their inclination to enroll (for those who are potential Open University students, as many are). The testing is quite a rough procedure, but it has given us early warning of overloading of units, of obscure passages, and of inadequate assessment materials.

Phase 2c: External Assessment

If the time were available, most authors at the Open University might want to amend their units at the end of Phase 2b, before the units were sent to external assessors, in Phase 2c. In fact, Phases 2b and 2c have often run concurrently. The external assessors are subject-matter experts in other universities who, for a fee, review the units from a subject-matter point of view and suggest amendments. The course team nominates the assessors, so there is no guarantee that Charlie's pal will not be nominated. On the other hand, the assessors have rendered valuable service, particularly in mathematics and science, in catching factual errors that had escaped detection during Phase 2a, or in suggesting that there were other points of view (particularly in areas such as biochemistry) which ought to be represented.

At the end of this Phase, the course team has to approve formally the text of the unit, and at the same time, with luck, will be able to approve the television film and the radio broadcast, which will have been produced by then.

Phase 3: Editing and Printing

In each faculty there are professional editors who are responsible for a good deal of the preliminary editing during Phase 2. In Phase 3 they prepare the written materials for the publishing division, which has its own editors to check on house style and so on. Since copyright had to be cleared for developmental testing (Phase 2b), probably no further copyright work is required. Marking up for the printer is a considerable task, and comes at this stage, of course.

Besides the basic course unit and the books published for the course as a whole, the student receives quite a pile

of supplementary items all of which have to go through this phase too. Notes for the television and radio programmes, glossaries, assignments, records or tapes in a few units, and so on, all have to be prepared for mailing. The supplementary items amount to about as much printed material as do the basic units.

The assignments that are to be marked by computer have to go through quite a complicated processing, undertaken mainly by members of my staff, to set up the programmes to do the marking. Each item has to be weighted correctly, for instance.

The output from this phase is of course a set of main components necessary for the learning system. Meantime, however, the University's regional organisation has been setting up local study centres; employing nearly 4000 part-time staff to act as tutors and counsellors; installing television sets, radio sets, cassette playback devices for both film and tape, and other items in the study centres, and hiring conventional university premises for an extended series of summer schools to be attended by every student for at least one week.

To devise a comprehensive description of everything that goes on to produce one course and to teach it to our students is possibly beyond me, but certainly I have used enough of our time to give you the impression that course production is a complicated process.

Some Early Steps in Course Production

The fact is, however, that the descriptions I have been giving of these phases omit a great many other factors and processes which have to be taken into account during course production. It would take far too long to go through all those factors and processes, so I propose to discuss just six major headings, out of many more under which these factors and processes can be grouped. In my opinion, these six are certainly among the first that should be examined by teams setting out on course production, and I hope they will help your sessions together this week.

The headings are as follows:

1) Proposing a course
2) Justifying a course
3) Production sources
4) Costs
5) Staffing
6) Students for the course

1) Proposing a course

I assume that the organisers of this conference agreed on titles for two of the courses to be discussed here (Biology for Everyman and Biology for Life Scientists). That is a beginning. The title for the other, the unit, still has to be decided, I think. Maybe some of you will want to change the titles later, but it is worthwhile trying to agree on provisional titles early on. The next stage is to agree on a 2-3 page summary, showing who the course is for, what general entry behaviour is required, what are the main aims and topics for the course, and what it will lead to. Again, this may be only provisional but it is sure to need a lot of debate.

If your group can manage to get that far quickly, as some indeed do, then you may tackle a first-version conceptual model, showing the main topics and their interrelationships. At this stage, we are dealing still mainly with subject-matter, rather than teaching techniques.

2) Justifying a course

Everyone who has proposed a course has thought up some justification for it, but some difficult questions need to be answered before proceeding further. Is your course really needed now? If not, will the need arise soon? Have other academics been surveyed for their opinions about the need for this course? You can proceed without them, to be sure, but that implies that you know better than they do, or that the need is extremely local!

Even if other academics are agreed, as they may well be in this conference, that your course is a good idea, have you considered consulting employers? In Los Angeles there are many institutions training computer punch operators, but it so happens that these operators constitute the largest single group of unemployed in the Los Angeles area. Such a strong vocational emphasis may not be likely in biology courses, but employers may have useful opinions that should be taken into account.

Let us say that both academics and employers agree that your course is probably needed. Should you proceed without consulting students? Enthusiasts have been known to produce courses in Sanskrit for the benefit of a privileged minority.

There is here a question of supplying or generating demand, as well as anticipating one. Black Studies courses may supply a demand; French literature ones may have to

generate a demand, while a course in materials design may anticipate one. For your group's course, it may be worth trying to find out what the demand is at present. If it is to constitute part of a professional qualification, say for teaching, then certain professional bodies may have to be consulted at an early stage, although many will not commit themselves until they see what the course is like and what people think about it. Ultimately, it is a matter of whether there will be enough students to justify the high development costs that are likely.

3) Production sources

By production sources, I mean sources of the components that will make up the course. At the secondary school level, for example, there have been some quite sophisticated classroom management schemes which have tried to provide the pupils with a 'learning programme', a set of instructions for the use of existing, published materials. Such schemes might be thought of as programmed learning in its broadest sense. They require a variety of materials, and frequently use only portions of each book, manual, atlas, reading kit or science kit supplied to the pupils. The development time and cost for such schemes is far lower than for those in which a completely new set of materials has to be devised, as in BSCS.

There are considerable problems in following the first alternative, associated chiefly with selecting the appropriate materials. Assuming that there are good collections of learning materials that can be examined, access to them is a problem. There may be many miles of good and bad film on topics in the biological sciences, reels and reels of tape about constitutional reform, and thousands of geological filmslides. Choosing the ones you want for your course if time-consuming, to say the least. What is more, you will almost certainly be dissatisfied with what you choose, and will feel that you could have had made just the right ones. Only when you have been through the choosing will you have a clear idea of all the criteria to be born in mind, although of course you will have begun with some idea of what you wanted. And when you have finally chosen, you still have to discover whether there are sufficient supplies available.

You may decide for your group's course that there is nothing on the market that is suitable. This is a common reaction among academics. There are so many bad textbooks around. Even the good ones do not really fit your purpose. If you do decide that new instructional materials are to be produced, as the Open University did, then you should start to

look very carefully at the next heading, Costs. As any publisher or educational innovator will tell you, the costs of software development are high indeed.

The Open University, as I think you will have realised, has decided to take the best from what is published already or, in the case of kits, is on the market. But this best was not considered to be enough, and the University is now one of the biggest producers of software at the higher education level. By the end of this year, over 500 films will have been produced, the same number of radio tapes, some 500 printed course units, and sundry other items. The exact cost of actual production, as opposed to distribution and servicing, is hard to determine at present, but a full 36-unit course at Foundation level probably costs about half a million dollars or more to produce. Students need six such courses to get a degree.

4) Costs

It may be a simple question, but have you obtained financial backing for your group's course? If you have, are there any strings attached? As soon as the profit motive enters the picture, your degrees of freedom are likely to be limited. For instance, Open University course units are large (A4 paper size) and awkward to display in bookshops. If they are made smaller, it will be difficult to lay out some of the illustrations or to permit students space to make notes as they read. Some of our television films are made so that people who do not have the printed unit fail to appreciate them very much. Should they be changed so that the general public can enjoy them? Colour film production costs more than black-and-white electronic production, yet colour sells better. Should you gamble on colour? These questions may be pertinent only to the Open University, but similar ones have cropped up in other projects where the profit motive has come in.

So if there is no financial backing yet for your group's course, it is probably better not to try to obtain it on the basis of predicted sales to the general public. Incidentally, sales figures do not indicate very well how many actual students there are on your course. One of our 'readers', a volume of over 800 pages, has sold twice as many copies as we have students enrolled in the course (8,000 students, 16,000 copies). It would surprise me if many of the non-students have read more than 100 pages from it.

Besides the production costs there are also distribution and servicing costs. A capital outlay and a recurrent one, if you like. In the context of this conference I think the production costs are the ones to emphasise, but if you devise a biology course for everyman that includes a great deal of laboratory work, the distribution and servicing costs may be very high. The Open University has spent vast sums to purchase materials for inclusion in the home experimental kits, for example, and will be spending more to rent laboratories in conventional universities for the summer schools.

In your budget for production, you need to allow for such items as authors, consultants, graphics artists, editors, film producers and technicians, picture searches, library services, copyright and legal services, printing, tape copying, developmental testers and external assessors, and so on. Each of the course teams at the Open University has a budget which shows how much it may spend on each of these items, although transfers can be made between them if necessary.

5) Staffing

Here the basic question is whether you have the staff to prepare the course. Can they cover the proposed subject-matter between them? If not, have you funds for hiring consultants? Will the consultants be able to get on with the work without having been specially inducted into your system, or otherwise trained to work in your ways? It may be easy enough to find somebody who knows a good deal about a particular topic, but be quite a different matter to get him to write well, to make good television films, or to speak well on the radio. He may be excellent when it comes to inventing a cheap device for your kits, but hopeless in meeting the deadline for preparing the written instructions for using the device.

Some would say that a strong chairman is the simple answer. In my experience, academics do not react well to dictators, yet there is no doubt that course production is more akin to an industrial operation than a research project. Staffing such an operation has to be approached in a fairly cold-blooded fashion to ensure the right balance of skills and knowledge within the team. Merely picking up interested volunteers will not do.

Probably the best way to get a good team is to pay attention to the system of rewards. Penalties abound: for example, the criticisms of peers, potential students, and

others. Rewards have to be built into the production process. The most obvious reward is cash, through royalities, patents and fees. Some of the most troublesome clauses in the conditions of service of Open University academics have revolved around these rewards. In whose hands should copyright lie, for example? Other rewards are to do with public, and academic recognition. Should the author's name appear on the unit, or the names of all those in the course team? The latter alternative will make people in the team take more notice of what the others are producing, resulting in a better product, but will deprive individuals of the right to claim one unit or another as theirs.

In a more general sense, if course production usurps too much of an academic's time he will come to feel that his research and research publication are suffering, and he will neglect some aspects of course production. There must be enough rewards in course production.

6) Students for the course

Not much at all is known for sure about students' characteristics, nor are these easy to discover. The one thing that is known for sure about students' abilities is that they are extremely varied. But what cognisance is to be taken, for example, of the varying reading speeds of the students for whom your group's course is intended? Or of their mathematical background (or lack of it)?

Is there much known about perception that will help in the designing of an effective course? Are there aspects of social class or cultural background that ought to be taken into account in preparing learning materials? Are there any reliable predictors of academic performance?

If we tried to specify the 'typical' or average student in the American college system, we would come up with some surprises, as the Report on Higher Education (Newman and others, 1971) has very recently pointed out. For instance, the typical student never graduates. Yet almost all the courses he may take are built on the assumption that he wants to and will graduate. Many of them are built on the additional assumption that he will want to go on to further work, possibly at the graduate level, in the same subject area.

We know so little about the average student, we prepare courses for the excellent ones, and we ignore generally the vast differences among them. Small wonder that students consider many courses to be largely irrelevant to

them. Social workers laugh at being taught the physiology of the ear and eye in their 'psychology' course; teachers attend in-service training courses to collect additional credits and go away to continue teaching in exactly the same way, and medical students learn by heart reams of matter that can be looked up in any standard textbook.

If there were time, I could go on to discuss more factors and processes that need to be taken into account in course development. Since there is not time, let me simply list some of those which I hope will get into your talks together this week.

7) Interdisciplinary approaches
8) The structuring of information
9) Course team group dynamics
10) Course development scheduling
11) Objectives, student activities and assessment
12) Selecting media
13) Providing for individual learning styles
14) Developmental testing techniques
15) Integration of various media
16) The role of face-to-face tuition

The Systems Approach to Course Development

Nobody wants to waste time learning jargon, and nobody wants to get tied up in a mass of gobbledegook invented by educational technologists. That is why I have tried to tell you in a straightforward fashion about the Open University's routines and about the first six headings. To close, however, I want to add a few words which may help to explain what the systems approach to course development implies. I have said already that MacKenzie and his colleagues believe in a systematic approach, and the Open University certainly exemplifies that kind of approach. But they also believe in a systems approach, one that draws many of its concepts from systems theory.

The purpose of course development is to enhance learning. A course thrown together without any planning is scarcely a course but what the systems man calls a chaotic aggregate! In the systems approach we are trying to bear in mind during course development as many components and variables in that system as possible. A system is simply an assembly of components connected together in an organised way to do something.

In course development, as we have seen, there is some difficulty in defining the boundary of the system. In discussing the justification for a course some might wish to reach deep into moral philosophy, while others accept the limits imposed by the marketplace. Because the course is only part of a larger system (the university) and the university is in turn within still larger systems, the variables that influence the system that is the course are influenced from far beyond that system.

Now a course is not an example of a black box system; we do know something of what happens between the inputs and outputs. On the other hand, there are black box components within the system, such as the learner himself.

The course does not represent a steady state either. Even though the instructional material may be 'stabilised' for a time by being published, other inputs in the system are changing, such as the characteristics of the learners. The systems man is very interested in the changes from one state to another of the whole system, and he is interested, as MacKenzie and his colleagues have pointed out, in making the optimum synthesis of components to achieve the desired outputs. Accordingly, the systems man tries to install a large variety of 'dials and guages' in the system so that he can obtain feedback and make adjustments within the system. Alternatively, he will try to arrange components so that there is automatic feedback and adjustment.

To translate these ideas into more everyday terms, we might say that the systems man is anxious to stress the interdependency of components in the course system. He wants to see tests closely related to objectives, and student activities closely related to both objectives and tests. He wants to see as little 'noise' as possible in the system, so that good judgements can be made about revising portions of the course, for example. He wants to see media and teaching techniques related both to the subject-matter being taught and also to the learners. He wants to see the subject-matter related to the future needs of students as far as that is possible.

None of this is very new, in the sense that somebody has thought of all of it before. What may be new is the emphasis upon approaching the course as a system. If you are going to make this kind of approach to the three courses that are to be discussed this week, you cannot sweep under the carpet and forget any of the sixteen headings that I have mentioned, and you will certainly think of others yourselves. At last, through the systems approach we are recognising that

there are a great many components and sub-components in a learning system, with an immense number of links between them.

The paper by Schmidbauer (1971) is an apt summary, and I hope you will examine and discuss it. Finally, let me bring you back to the Chapter from Teaching and Learning. By now, I hope that you will feel that the theoretical system that is described in that chapter can be brought to bear on reality. I hope that terms such as students input, instructional input, and intended outcomes now have practical meaning for everyone here, and that we will all agree on the need for feedback or evaluation as a basis for improving the prototype. I hope that by describing the Open University production process and discussing some of the major factors and processes to be borne in mind, I have increased the chances of this Conference being a successful beginning to the production of successful courses. Cooperation is good and vital for course production. I myself will be happy to cooperate with all the groups during the rest of the session and wish you all the reward of feeling that you have achieved something good by the time I come to sum up at the last meeting on Thursday.

Dahllof, U. S. and Lundgren, U. P. — Macro and micro approaches combined for curriculum process analysis: A Swedish educational field project. Goteborg, Institute of Education, University of Goteborg, 1970.

Dyer, H. — An educational researcher's view of systems analysis. Educational Technology, September, 1969.

Good, H. M. — Inter-university Co-operation. Kingston, Ontario, Queen's University, 1971.

Lewis, B. N. — Course production at the Open University I: Some basic problems. British Journal of Educational Technology, 2, 1, January, 1971.

MacKenzie, N., Eraut, M. and Jones, H. C. — Teaching and learning: an introduction to new methods and resources in higher education. Paris, Unesco/International Association of Universities, 1970.

Markle, D. G. — Controlling behaviour changers' behaviour. Audiovisual Communications Review, 16, Summer, 1968.

Morrisett, I. and Stevens, W. W. Newman and others — Steps in curriculum analysis: summary outline. Privately circulated, 1967. Report on Higher Education. Washington, D.C.: Government Printing Office, 1971.

Platts, C. V. and Wyant, T. G. — Network analysis and the possibility of its use in education. Educational Review, February, 1969.

Schmidbauer, M. — The systems approach and the development and planning of media systems. Council for Cultural Co-operation Paper. CCC/EES (71) 52. Strasbourg, Council of Europe, 1971.

THE WORKSHOPS

General Introduction

The workshops were the heart of the conference. They were the testing ground for the ideas which initated it, which were sent out in the study materials or presented in the keynote address. These workshops tell us much about the receptiveness and state of preparation of the delegates. It is on the basis of what went on in them that we can attempt to answer the questions posed in the preface. It is therefore essential to present some detail of what happened in the groups, to compare them, and to suggest possible bases for their successes and failures. This has been done as concisely as seemed consistent with their importance to an evaluation of the conference. The steps each group went through are reviewed but course outlines developed during the conference have been omitted.

Workshop 1 (design of a course for the student not proposing to specialize in the Life Sciences) had its origin in the rising interest in biology in relation to the environment and to the population explosion. Most universities have courses of this type.

It was a relatively popular workshop. Of the 76 delegates who were teaching biology, 25 gave Workshop 1 as their first choice. This workshop attracted the most experienced teachers at the conference with an average of about 15 years of university teaching.

The assignment for Workshop 2 was like that of Workshop 1 in being a full year's course, but was quite different in substance. The problem was to design a first year course for students who intended to do a specialized degree in the life sciences. It was therefore to be introductory, the first of some ten courses in biology the students would be taking. It could assume a high school

background in mathematics, chemistry and physics as well as concurrent courses in these subjects. Workshop 2 was the most popular with 36 of the 76 teachers giving it as their first choice. This group was considerably younger than the groups applying for the other workshops, with about 8-10 years of experience.

Workshop 3 differed markedly from the other two workshops in that the assignment was limited to a short unit or module which could be used as part of a variety of courses. This made possible a greater depth of treatment as well as some chance of completion of a unit. These advantages over the other workshops were pointed out to the delegates before the conference. However, few delegates showed interest in Workshop 3. Of the 76 who were teaching biology, only 15 gave this workshop as their first choice. Some who had given it as a second choice or had not indicated a preference were assigned to Workshop 3, but this still left a smaller number than in the other workshops. It was therefore split into two groups instead of three. Those in this workshop had almost the same experience as those in Workshop 1.

The following accounts of the three workshops give, in abbreviated form, the address of the workshop leader and an account of the progress of the workshop during the three and a half days of meetings. This account is presented first in tabular form to bring out major parallels and divergences and then by a fuller commentary in the form of an account of one group (normally whichever one happened to provide the most detailed notes of its deliberations), followed by a briefer description of the work of the other groups. Incorporated into these accounts are comments by the editors on the differences between groups and the possible reasons for these. Commentary of this type inevitably becomes evaluative. We have not tried to curb this tendency since it seems that some evaluation of the group activities falls most rationally into this section rather than into the later section on evaluation of the whole conference.

The basis for an evaluation of the success of groups such as these is tenuous. The conference planners had no intention of offering groups rigid assignments. However, the preliminary material and the keynote address laid down fairly definite themes and suggested approaches which gave some expectations against which 'success' of at least some kinds can be judged.

WORKSHOP 1 - Biology for Everyman

Introductory address

Biology and Social Change

John L. Southin
McGill University

In designing a biology course for the non-specialist we are faced with three problems: how and why to teach it, and what to teach in it. I take it that most universities have by now abandoned the hard-line to the effect that "the best course to give to the non-specialist is that given to the specialist". Let us hope so, at any rate. Nor do I want to enter a potentially interminable and inevitably doomed discussion of what to teach the non-specialist. Surely students coming to a biology course from a variety of other disciplines will each want different things out of it. Let them choose. True, the discipline involved in memorizing the minutiae of meiosis or of succession in a bog has worked wonders in reforming our own characters, but we must struggle ceasingly against prescribing our medicine for others' ailments. So I am not going to mention content much either.

A course that was once "terminal" (like decapitation!) can now become the vehicle for awakening every student's latent interest in Biology.

Conceding the need to permit students a wide measure of choice in what is taught them almost demands that the course be presented in a module format. At the present time there is no general agreement on exactly what a course module is. Since academics are well used to scoring debating points by demanding, on all occasions, that bearers of new ideas define carefully their terms, we feel very uneasy when asked to consider a concept not yet straight-jacketed by a definition. Perhaps we should be reminded from time to time that the term "gene" figured in biology with increasing importance for forty years before it was possible to attempt a satisfactory definition. For the purposes of this talk, a module is just "an autonomous unit of self-study within a course".

Modules can differ within a course and between courses. Each can be structured in an identical fashion or there can be a variety of structures within the units of individual instruction. All of the modules may be required, or alternatively, you can offer the students an array of modules and say take ten - or whatever. You may demand that a student "master" the material, or you can say, as we do in most conventional exams, that understanding some fraction is sufficient. You may have within the module very clearly defined objectives. Or else, for a more philosophical subject, having precise objectives becomes less practicable, if not impossible.

Let us proceed on the assumption that the course will be modular. There are certain ideas we must bear in mind. Students ought to be actively involved in learning. "Biology for Everyman" should also have a very strong community outreach - or whatever other circumlocation one chooses to avoid saying "relevant".

To illustrate the type of course I have been discussing I shall explain in some detail how the course that we teach at McGill has operated.

The course is called "Biology and Social Change/Environmental Issues", given as a year-long course to over 300 students enrolled at two separate Montreal universities. The students enroll for the course at their home university, and each university funds and administers the course as if only its own students were involved. At the level of the student, however, all resources supplied by the two schools are completely shared and the two populations mix indistinguishably. As the title suggests, the course is inter-disciplinary. It is taught by a geneticist at McGill, a historian of science at near-by Sir George Williams University, a few paid assistants, and a host of volunteers. There are no required lectures, no compulsory conferences, no course outlines and no compulsory exams.

Sir George Williams University made available eight media-equipped rooms and a complete television studio for our weekly television show. The optional lectures are also offered at SGWU. McGill, with its well developed professional faculties and graduate program, supplied most of the academic resource specialists.

The Drop-In Centre should be singled out for special mention. It is a large, comfortably furnished alcove located in McGill's undergraduate library. The Centre is available to students from 7 a.m. to Midnight. Course staff are on duty at

scheduled times, generally from 10 a.m. to 5 p.m. every weekday. At these times, our own Drop-In library (less grandiosely, a large cupboard shelving several hundred books , module files, and individual student's progress sheets) can be consulted. Students come also to "read the walls" where course notices, student advertisements for project partners, skill-exchange proposals, newspaper clippings, and other academic graffiti are always being posted. The library location for the Drop-In Centre was deliberately chosen so as to attract into the many events of the course students who are not formally enrolled. In this we have been very successful; some of the course projects and study groups now have a majority of the participants from outside the course.

This year, with almost no advertising, we assembled a large number of non-academic professional and lay volunteers eager to contribute their skills to our enterprise. These included doctors, medical students, drug users, Indians, lawyers, teachers, a retired zoo keeper, engineers, and local citizens' groups. Only a few of these volunteers are prepared to deal with more than a single module, but in that particular area they are often more qualified than the official instructors. Moreover, the use of community volunteers also provided creative and satisfying avocations for many who, through personal circumstances, have few other occasions to exercise their degrees, talents and interests.

The subject matter of "Biology and Social Change/Environmental Issues" is organized into autonomous self-study units called Modules. Most modules consist of an Introduction, Reprinted Readings, Study Questions, a Resource List suggesting the use of readily available learning aids (films, tapes, museums, etc.) and finally, suggested Projects. We have had about 70 modules ranging from those of a purely biological character (e.g. Biological Basis of Sex), to those with more equal biological/social science content (e.g. Genetic Engineering). Some modules are recommended as prerequisites to others. After he has selected a module the student also chooses how to be evaluated.

Since most of our students have little or no prior biology, we are now writing a Reference Monograph relating many specific biological concepts (DNA, meiosis, hormones, etc.) to specific and interesting social issues. We have found that we should spend the first few weeks introducing not the content of the course, but its format. It is unrealistic to expect students to abandon without anguish the passive modes of education they have long been used to.

Whenever a student wishes, he can make an appointment with a course assistant for an Oral Examination. Since course assistants (including the professors) are not equally competent to give an oral examination in all modules, a list posted at the Drop-In directs students to the one or more assistants who are responsible for the content of each module. This oral examination, which lasts usually about 15 minutes, can be scheduled at any time and place mutually acceptable to the examiner and student. They are marked pass/fail/honours, and the results entered within a week in the student's Progress Sheet at the Drop-In Centre. There is no penalty for failing an exam, and they may be retaken as many times as necessary.

Participation Projects are also a basis for evaluation. Autonomous Study Groups may be set up at the instigation of interested students. A minimum of four or five hours of actual discussion time is required for each module chosen, and a report of the group's activities must be signed by all participants and submitted for credit.

A common type of response is a project based on a course module. Montreal, like other North American cities, is a perfect laboratory for imaginative student projects on pollution, race relations, health care availability, birth control data, environmental law, drugs, alcoholism, and so on.

Course Communications

Every Friday afternoon at 2:00 a student-produced videotape, nicknamed TV-Friday, is relayed by closed circuit into the eight classrooms. Student response has been somewhat disappointing. On the other hand, the quality of presentation improves strikingly during the year.

For four hours every week an entire TV studio is turned over to a crew of thirty students. Each production crew is responsible for the research, scriptwriting and actual presentation of every third show, organized around one module. There is also ample opportunity for "free-lance" TV work by individual students or small groups working outside the TV-Friday setup. Periodic public screenings of these individual efforts are also scheduled for the benefit of whoever shows up.

The principal aim of TV-Friday is to stimulate discussion and further reading, not to convey information. Not that TV-Friday is entirely lacking in imagination. One production crew produced a thirty-minute program on racism and the plight of Quebec Indians, which was re-broadcast by one of

the local commercial television stations. This year many of the shows are being broadcast by a local educational cable TV station.

Source Sheets, a collective term for the hand-out material students receive at the beginning of the year and at frequent (though irregular) intervals thereafter, later took the form of a mimeographed course Newsletter prepared by the students under the editorial guidance of a course assistant.

An optional Lecture Series has been instituted this year, and students can earn about half of their total credits by writing an examination on the weekly guest lectures. About one-quarter or fewer of the students offered these lectures. There are also dozens of seminars based on particular modules or groups of related modules. These are organized and led by our paid and volunteer staff and are usually held over several weeks at the Drop-In Centre. Finally, a student-organized weekly Cine-Club programs and screens over 50 films on various course topics during the school year. These events are open to all McGill and SGWU students.

Evaluation and Grading

Instructors are delighted to evaluate a student's work, but only when this is requested. Otherwise, student work is given a relatively cursory examination and judged as "acceptable" or "not acceptable". Acceptable work is awarded a given number of points according to a pre-determined scale. An oral examination earns three points; a study group three points; a critical book or film review one point; and so on. Extended projects (such as TV-Friday or community service work) may earn up to fifteen points and are negotiated independently and in advance. All projects and seminars require that students first write a Contract which must be approved by one of the Project Co-ordinators. The finished work is always compared with the contract and only when it has been carried out as originally agreed upon, is it awarded the designated number of credits. The grades of D through B are quantitative and are solely determined by the number of credits a student accumulated. The A is awarded to those who have done B-level work especially well and is frankly qualitative and subjective.

Appraisal

Certain deficiencies of the modular system have been noted during the first year. The tendency of some students to compartmentalize their thinking and their failure to attempt an integration of more general themes is particularly

deplored. Another possible weakness lies in our failure to specify clearly the instructional objectives of each module.

Since there is no specified sequential arrangement of modules, a "mosaic" of scholarly ideas, events, experiences, and encounters replaces the usual "linear" pattern. While probably not appropriate for more advanced learning situations, this format seems particularly appropriate for courses designed to awaken student interest.

Another criticism levelled at the course is the charge of superficiality and the failure to encourage critical thought. We believe it equally important to avoid rote learning of minutiae on the one hand and airy generalizations, however dramatic, on the other. Critical thinking will never be programmed. It cannot be sold by job lots, no matter what "system" is used. We question whether there is any necessary correlation between examsmanship and profundity of thought. Most importantly, we believe "Biology and Social Change/Environmental Issues" offers challenges which are healthier motives for learning than the arbitrary pressures of the regimented classroom.

(Readers wanting a more detailed description of the procedures used in this course can get the various hand-outs by writing to Dr. Southin, at McGill University, Montreal).

Review of Workshop 1

The reports submitted by the three groups in Workshop 1 were very uniform in the detail they provided and, as Table 3 shows, there was a good deal of consistency in the way that they dealt with their subject matter. The report of Group A is presented as representative and comments on the others are made in relation to this.

Workshop 1 - Group A

Group A began by considering the need for a course such as "Biology for Everyman". There was general acceptance of the need. Discussion of the reasons for it led to a definition of aims. The course should offer the student:

1. a basis for understanding scientific methodology
2. a basis for informed participation in decision making
3. development of a continuing interest in biology
4. additional awareness and enjoyment of life
5. improved awareness of self
6. breadth and/or depth of understanding of biology

Preliminary discussion of modules and of need for laboratories proved unprofitable and an attempt was then made to define what the clientele would be! This led to the conclusion that the students would be: variable as to age, interest and background; non-science students; without need to build a specific body of knowledge; with a desire to take the course.

It was suggested by Dr. Hawkridge that these constraints be defined more fully. This led to the following statement of constraints.

A course enrolment of 200

A one-term course of 12 teaching weeks

20% of a full-time student's load (6 hours of <u>total</u> - not contact - work per week)

Several constraints remain to be established, viz.:

What proportion of instructional time would be devoted to lectures, laboratories, seminars, etc.

Table 3 - Sequence of Main Topics Discussed in the Three Groups of Workshop 1 - Biology for Everyman

Day	Group A	Group B	Group C
Monday 17th	Need for course Aims Constraints	Types of students Concepts Acceptance of modular design Aims	Delegates goals Need for courses Aims Content and its relation to possible modules
Tuesday 18th	Acceptance of modular organization with each module to serve all aims Methods Design of introductory unit of module - "Resources and Productivity"	Correlation of content and methods Selection of topic for detailed consideration - "population growth". Design of a module on "predation"	Constraints, Cooperative production of modules Methods Revised statement of content Choice of topic for detailed study - "Mendelian Genetics"
Wednesday 19th	Continued development of module on "Resources and Productivity" in 6 stages: 1. introduction 2. basic information 3. experiment 4. biological principles 5. project 6. final discussion each stage with specified objectives and appropriate methods. Design of a course based on module of 6-week duration	Continued design of predation module Discussion of role of modules in course design	Design of a module on Mendelian genetics to include: 1. workbook with objectives, summary of ideas, readings, etc. 2. lecture 3. lab experience 4. group analysis of results 5. film of human applications of Mendelism Student assessment Review of modular design of course
Thursday a.m. only	Continued work on module	Continued work on module	Continued work on module

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The degree of flexibility in student's choice of content or methodology

Budget available.

Flexibility in content and method was recognized as one means to handle the variability of student background and interest. It was therefore agreed that for present purposes the group would strive to provide complete flexibility of content within the range of material that can be offered. For this purpose the group decided to concentrate on the modular approach (a module being defined in Southin's sense as a subunit of a course that can be chosen by the student). Each module offered in a course should illustrate, so far as possible, all the aims for the whole course.

An additional aim was then added to those listed the previous day, viz. to train in approaches to learning.

A list of 27 possible titles for modules was drawn up and one of these - Resources and Productivity - was chosen for further development. It was agreed that this topic should illustrate the scientific principles of energy flow, photosynthesis, interactions, and limiting factors. The general content should include: man as a member of the food web; primary and secondary producers and consumers; the earth as an ecosystem.

In discussing methods it was felt that the subject matter should proceed from that which was general and familiar to students to the specific and back to more general and perhaps applied aspects.

The major available methods were listed as:

1. lectures
2. small group discussions
3. "set" laboratories
4. projects (laboratory or field)
5. audio-tutorial presentations
6. selected readings
7. learning cells

It was agreed at this stage not to specify either the particular approach to be used or the total length of the course, but to adapt these to the content during module development.

A "set" laboratory exercise was then devised involving observation of an aquarium representing a complex ecosystem. Students were to be able to answer, during the lab or a small group discussion afterwards, the questions: what is there? how are they interacting? what are the essential elements of this system? what is the basic source of energy?

Selected readings were to be provided relating to basic aspects of such a system and/or its extrapolation to other systems including those involving man.

On the following day the group continued to develop the module on "Resources and Productivity" which was to be presented in six stages:

1. Introduction
2. Basic information
3. Experiment
4. Biological principles
5. Project
6. Final discussion

After completing the outline, it was compared with the previously-stated aims, and found to be compatible. Discussion of student assessment procedures led to agreement to use several types of formal graded assessment to be provided at stages 3, 4, 5 and 6.

The stages which had been less fully developed (numbers 4, 5 and 6) were examined in more detail by sub-groups of 2-4 people and the recommendations of the sub-groups incorporated into a general re-examination of the course outline, during which specific approaches were assigned to each stage. The next stage would probably be examination of costs which did not appear likely to be higher than usual.

A course outline was then prepared. The course was called "Biology for the Layman" and had a length of 12 weeks and a credit value of 20% of a full-time student's time for

one term. The composition of the course would be two modules, chosen by the student from a wide range.

Workshop 1 - Group C

The course of events in Group C was comparable but far from identical to that of Group A. Group C began by asking each member to describe his or her reasons for coming to the workshop. Most wanted to improve courses such as "Biology for Everyman" which they have either been giving or planned to develop. Some were particularly interested in the relationship between science and social action and the ways in which student interest in this relationship could be harnessed with advantage to the teaching-learning process. Still others were particularly concerned about science training for professionals such as nurses and psychologists. The group went on to enunciate the aims of the proposed course and then to consider topics which might be included and how these might be related to modules of instruction. On the second day they reviewed constraints and discussed the possible advantages of a cooperative (i.e. inter-university) production of modules. Methods were discussed and the list of topics was revised. One topic was then chosen for a trial run at development of a module. The way in which this was to be approached is listed in Table 3. The group ended with a consideration of student assessment and a review of the work they had done during the preceding three days.

Workshop 1 - Group B

Group B began with a consideration of the types of students likely to be involved and proceeded to a consideration of the main concepts which the course should cover. They then accepted the idea of a course made up of modules and at the end of the first day were ready to set down their aims.

On the second day they charted a correlation between content they might include and the methods which might be used, then chose a topic "Population Growth" within which they selected the subject of "predation" on which to base a module which would be consistent with their earlier discussions on aims as well as with their discussions of methods.

Workshop 1 - Discussion

A noteworthy feature of the work of all groups was the repeated reference back to the early discussions of aims and methods. This iterative approach had been stressed in the preparatory reading and strongly emphasized again by Dr. Hawkridge. Undoubtedly the recognition that there would be recycling helped avoid clashes and fixed positions.

The specific content did not become an issue in Workshop 1 though it is worth noting that the groups chose quite different subjects for the sample modules they developed. This is probably for two reasons. Since the course is not required to prepare for any specific higher level course, there is little basis for a strong stand that some specific material must be included and since all groups accepted the concept of a modular course with at least some student choice of the modules, each could study the design of a module as the critical problem. As one group decided, everyone should discard their "special interests and viewpoints".

The uniformity of approach of the three groups was no doubt due in part to the nature of the assignment and in part to Dr. Southin's persuasiveness and close attention to the groups in his workshop. It is clear that the modular concept which was outlined in detail in his address caught on - no doubt aided by the fact that the assignment of Workshop 3 was essentially applying this plan. Mr. Dowdeswell and Dr. Mercer, who were with that workshop, were indeed "borrowed" briefly by Group C late in the conference to discuss modular instruction.

All groups showed a determination to avoid superficiality though this is difficult for those who attempt to integrate the knowledge of a particular discipline with a wider learning experience for the student. There is no doubt that the "subject" will suffer. Content in the traditional sense will necessarily take second place. This is especially true when there is a determination as there was in some of the groups of Workshop 1 to have each module serve all the aims of the course. When the objectives of the course are different, as we shall see they were in Workshop 2, different criteria for the selection and treatment of content become applicable.

The dilemma of providing adequate content in general courses can be softened if one is prepared to recognize that different modules can be constructed to emphasize different goals. For instance, one module may be used to test and develop the student's capacity for observation and discovery.

Another module may be designed to develop the student's ability to apply fresh factual knowledge to problems already encountered in another context. Whether a module is designed to serve all objectives of the course or only one, there was general agreement about the need to motivate students throughout the course by capturing interest, "showing relevance" and stimulating thirst for discovery. "Taking the student from the familiar to the unfamiliar" was an accepted axiom.

Most groups identified a dozen or more methods of instruction which might be employed in various mixes depending on the content and purpose of particular modules. Ideally, it was agreed, students should have some degree of choice in specific content which they might wish to pursue and the methods by which the pursuit is carried out. Face-to-face feedback was considered essential by all groups. Most felt that the kind of course discussed could not be offered on an extramural basis though some discussion in Workshop 3 challenged this viewpoint. Some lab-work and discussion were considered essential.

Only Group A found time to consider problems of student evaluation in any detail. It was recognized that progress towards objectives such as "enjoyment of life and self" or "respect for the environment" could not be measured in quantitative terms. This did not mean, however, that such objectives should not be kept in mind in designing a course. One group hoped that students would select the course out of interest. Another felt that the course should be for everyman whatever everyman's motives might be. Even a student simply looking for a credit and taking this course as the least objectionable among several would be susceptible to instruction designed to fan any spark of latent curiousity within him.

At the final plenary session, Dr. Southin commented on the work of the three groups with which he had worked. He considered that his groups had gone fairly different paths, but that all had agreed that a biology course for everyman, i.e. for the non-specialist, should have a large degree of flexibility. There was considerable discussion of the breadth versus depth controversy. Dr. Southin stated that his view that breadth was preferable had not generally been accepted, that many of the groups felt that students should have choice in selecting components of a course, but that once they had chosen they should then study that subject at considerable depth. One of the groups argued that there should be a core program. After completing this, the student might then select a specific area for study.

The modules developed were variable. In one which seemed especially interesting there was an initial experimental approach which was designed to lead to questions and these in turn to reading and discussions, the whole unit taking six weeks. Only two of these modules would be required to make up a semester course or four for a regular year long course.

The groups had been of the opinion that while their size (about 10-12) had been useful for an exchange of views and for learning something of the systems approach, they were clearly too large to be effective in designing specific courses or modules. In spite of this, most of the participants had felt their time on the projects well spent.

WORKSHOP TWO - Biology for Biology Majors

Introductory Address

R. H. Haynes
York University

Science teaching in universities is a difficult subject for scientists to discuss because teaching is not itself a science: educational methods and curriculum design seem to be based more upon the intuitive beliefs and subjective experiences of professors than upon theories tested (or testable) by controlled experiments. Indeed, it is unrealistic to expect that "education" can become "scientific" until we are prepared to carry out many more properly controlled experiments in teaching in universities. The university professor here faces a dilemma similar to that of the physician who is naturally reluctant to prescribe for a "control group" of patients a placebo or traditional mode of therapy when an allegedly superior treatment becomes available. In the same way professors seem to be unwilling to make properly controlled comparisons between new and old teaching methods or curriculum designs. This leads inevitably to a doctrinaire approach in which educational propositions asserted by the loudest voices tend to be inflicted uncritically upon students. Thus, it should not be surprising that most of the remarks here are hortatory in tone and based upon nothing more than my subjective experiences in organizing and teaching introductory biology courses at York University and at the University of California in Berkeley.

There are two interrelated aspects of course design that must be considered:

1) Methodology and Operational Practices

2) Course Content

In this discussion I will assume that there is established a set of explicit course objectives. However, I realize that we often do not have a very precise idea of what our objectives are - otherwise we would not have such difficulty with that most perennial student question, "what am I responsible for?" The problem of clarifying one's

objectives in any course is by no means trivial, as Benjamin Bloom has amply demonstrated in his analysis of educational objectives in the cognitive domain (1,2).

While the teaching of almost any subject is likely to benefit from properly controlled revisions in methodology and operational practices, I believe that in biology we are faced with an even more important need for revision in the content of introductory courses to reflect the ecumenical forces in the biological community that are serving to re-unite our fractured, and often fractious, discipline. Arguments supporting this latter view have been eloquently stated by R. Y. Stanier in his essay "What is included in modern biology?" (3). The actual contents of new introductory courses at four U.S. universities have been analysed by the Panel on Undergraduate Major Curricula of the A.I.B.S. Commission on Undergraduate Education in the Biological Sciences (4).

Methodology

Perhaps the most fundamental error that permeates the educational establishment today is what L. M. Stolurow has described as the 'communication-learning' fallacy which assumes that 'information transmitted to the student is learned' (5; see also ref. 2, pp. 46-48). The prevalence of this fallacy in an age of TV entertainment is not hard to understand: the student becomes a passive 'audience' for the professor, perhaps applauding, but not actively learning. Clearly, teaching is an impossible endeavour if the student refuses to learn: the best we can do is to provide a stimulating environment in which a well-motivated student can learn, that is, can teach himself. Because learning rather than teaching is the active process, Jerome Bruner of Harvard University, and other educational psychologists, suggest that our operational practices should focus upon mechanisms for the motivation of learning, and techniques that will gradually move a student from reliance upon extrinsic to intrinsic rewards in maintaining his motivation. Considerations such as these enable us to summarize in the following chain of rubrics what I believe to be the key ideas in teaching methodology:

(1) Learning, rather than teaching, is the essence of the educational processes

(2) Learning requires motivation

(3) Motivation for learning depends upon immediate (if not continuous) rewards

from the environment

As teachers we must try to design a learning environment in which the student receives appropriate rewards in order to stimulate and maintain his motivation to learn. Ideally, the teacher himself becomes a "learner" so that the student can see the educational process not as a unidirectional pumping of facts into him, but rather as a community enterprise in which he shares the excitement of discovery with teachers and other students alike.

A few years ago John Rader Platt, then Professor of Physics and Biophysics at the University of Chicago, wrote an essay entitled 'The Motivation of Creation" that should be read by anyone who would be either a creative scientist or, I believe, an effective teacher (6). In this essay Platt outlined a number of devices that one might use to maintain and enhance one's own motivation in research. However, I believe that it is valuable to suggest these same devices to students to aid them in their learning, because, for the student, learning should be as creative a process as discovery or theorizing is for the scientist. Platt's devices are the notebook, the collaborator and the audience.

Students should be encouraged to prepare and to keep detailed notebooks on each topic they are studying because the notebook provides self-feedback and is an immediate stimulus to the mind. As Platt says, 'the notebook forces your reason to stay at the highest creative level because the critic you face at every stage is yourself'.

Students should also be encouraged to collaborate with other students (and teachers) in their work because "the intensity and stability of personal coupling mechanisms to other people keeps our interest alive'. This must be peer interaction; it is not Mark Hopkins with his student at the other end of the log. It is Watson and Crick or Lee and Yang or Luria and Delbruck striking intellectual sparks off each other in friendly competition!

Finally, students should be given frequent opportunities to present what they have learned to audiences of their peers. The demand to speak to an audience is the ultimate stimulus to organize and polish one's ideas. And such public speaking feeds one's vanity while public disagreement or criticism is a strong stimulus to think hard again.

Operational Practices in Introductory Courses

The following practical questions and topics should be considered in planning introductory biology courses and were presented as items for discussion in the workshop:

(1) Breadth versus depth: should an introductory course attempt to survey all of biology or should it concentrate on particular areas?

(2) Pre-requisites: should biology be deferred to the sophomore year until an adequate knowledge of chemistry and physics has been attained?

(3) Relation of labs to lectures: can they be effectively co-ordinated?

(4) Use of TV: is it effective or desirable in either lectures or labs?

(5) Nature and frequency of exams and tests

(6) The importance of review question sessions prior to tests

(7) Role of tutorial or discussion groups

(8) Team teaching to multiple sections: its value for both teachers and students

(9) Administrative problems: how to organize a single introductory course serving more than one life science department

(10) Texts: paperbacks versus large, survey works

(11) Role of problem solving in biology: the need for problem lists

(12) Student performance: lack of correlation with prior training in high school

Content of Introductory Courses

In recent years a number of institutions have introduced biology "core curricula" at the second and third year levels designed to provide all students, irrespective of

Table 4 - Summary of progress of discussions in the groups of Workshop 2

Day	Group D	Group E	Group F	"Splinter"
Monday 17th	Where to begin the assignment High school background of students Possible content for the course Preliminary consideration of objectives	General aims of the course List of 6 principal objectives Constraints Shortcomings of present courses Student motivation	Open discussion centered on content Relation to chemistry and physics The survey course and when it should be given Objectives	(participants were part of Groups D and F for the whole of this day)
Tuesday 18th	Content of course - 6 unifying concepts Constraints Objectives Methods of teaching and of evaluation	The philosophy of the course Conclusion that "content" is largely an irrelevant issue Teaching methods and relation of these to objectives	Aims of the course Principal concepts and choice of topic - "interrelationships" for development of instructional unit Methods of presentation	Aims Principles and assumptions Rejection of survey courses Core curriculum Integrated science course Content of a module on "energy" for an integrated course
Wednesday 19th	Role of tutorials and laboratories	Assessment of students and program Assessment of techniques in relation to objectives Review of objectives	Continued work on unit on population cycles as part of topic "interrelationships"	Problems of planning, designing and mounting an integrated science course Planning for August conference of 3 days to try to outline such a course
Thursday 20th	Joined Group F	Worked on module	Field trip	Continued planning of August conference

their specialized interests, with a basic introduction to the central ideas of biology. The core curriculum being developed at the University of California, Berkeley, is based upon a new introductory course given to sophomores who have completed freshman requirements in physics and chemistry. The new course, called Biology 1, was designed to introduce students to the basic ideas and general principles of biology from a unified point of view. The syllabus of this survey course was distributed to all participants in the workshop as a basis for further discussions on what should be included in such courses. At York University, a similar course of study has been instituted as part of an Interdisciplinary Science Programme that all entering science students must complete before proceeding with the more specialized upper division programmes. However at York, two years are devoted to covering much the same ground that is covered at Berkeley in one year: this makes possible a more thorough coverage of most topics and represents a compromise approach to the depth versus breadth dilemma in the design of such courses. The York syllabus was also introduced to the workshop as a basis for further discussions of course content.

References

(1) Bloom, B. S. et. al., Taxonomy of Educational Objectives Handbook I: Cognitive Domain, Longmans Green, New York, 1956.

(2) MacKenzie, N., M. Eraut and H. C. Jones, Teaching and Learning, UNESCO and the International Association of Universities, Paris, 1970.

(3) Stanier, R. Y., What is included in modern biology? In: Biology in the University, Problems and Prospects, Proceedings of the University of California Special All-University Faculty Conference on Biology, Davis, California, 1963, pp. 7-13.

(4) Content of Core Curricula in Biology, publication no. 18, Commission on Undergraduate Education in the Biological Sciences, American Institute of Biological Sciences, Washington, D.C. 1967.

(5) Stolurow, L. M., Programmed instruction and teaching machines. In: The New Media and Education: Their Impact on Society (P. H. Rossi and B. J. Biddle, eds.) Aldine Press, Chicago, 1966.

(6) Platt, J. R., The Motivation of Creation. In: The Excitement of Science, ch. 8, Houghton Mifflin Co., Boston, 1962.

Review of Workshop 2

Workshop 2 began as planned with three groups. Within the first day there were signs that major differences in outlook within two groups were making it difficult for these groups to make progress. Towards the end of the first day, sub-groups within Groups D and F had decided that it would be better if they withdrew and constituted themselves as a fourth group. This is referred to as the Splinter Group. After electing a chairman, it operated much as did the other groups.

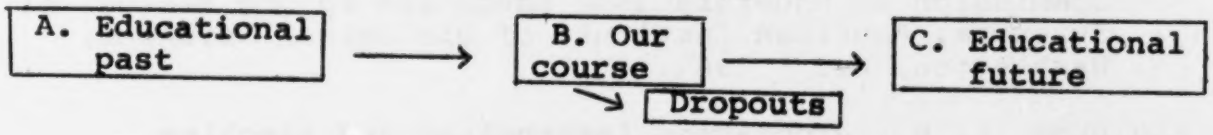
The general trends of the discussion in the four groups of Workshop 2 are shown in Table 4. This table shows that discussion followed quite different paths in the four groups. Indeed, from the chairmen's reports the discussions were even more different than appears in the table where any discussion of a topic, e.g. "objectives", appears the same whether it was a perfunctory listing or an exhaustive examination of objectives and whether they were general or operational ones.

The workshop reports for most groups which were prepared at the time of the conference are sketchy. This is particularly so for Groups D and F. We shall proceed therefore to the report of Group E in some detail and to compare the others with it.

Workshop 2 - Group E

Group E considered that its job could be divided into defining the principal aims of the course (what it is supposed to achieve, and for whom) and how it should be constructed.

The principal aim could best be defined by stating what the desired effect of such a course should be and who should be affected. The following model was drawn up.



The blocks represented in this diagram were described more fully as follows:

A. Entering students would have completed satisfactorily a high school programme including a training in

chemistry, physics, and mathematics. They would be proficient in the use of language and would intend a career in some branch of bioscience.

B. There would be no stated "gate" type prerequisites for our course but "A" would be assumed.

C. Students are to be ready to carry on with a bioscience B.Sc. programme or its equivalent, or may desire to take a broader less intensive training.

The group felt that the role of "bridging the gap" between high school and the professional training of bioscientists (including medical scientists) implied by this diagram was a basic aim and that this aim could only be achieved if the following objectives were fulfilled:

1. maintain or create interest and enthusiasm for biology among the students.

2. develop in the students a scientific approach to biological problems, and an ability to formulate principles out of empirical observations.

3. give the students some knowledge of how to observe and measure biological phenomena and of how to record and evaluate such observations.

4. develop in the students an understanding of the unifying biological concepts and an appreciation of the variability of the living world.

5. familiarize the students with a limited amount of biological jargon and fact (this is a necessary by-product of 4).

6. develop the ability for "self-learning" in the student, and encourage independent thought.

It was recognized that these objectives can only be fulfilled in a department where all staff members acknowledge the paramount importance of first year courses.

Before proceeding with a discussion of the educational methodology necessary for the fulfillment of the above aims and objectives it seemed appropriate to analyse present courses with a view to recognizing their shortcomings and to establish the constraints or limiting factors.

There was general agreement that present courses do not fulfill the aims and objectives as set out above. Two reasons for this appeared to be lack of integration between grade 13 and first year university and failure of present courses to motivate the student, resulting in a very reduced effectiveness of the learning process.

At this point the discussion became centered on the problem of educational motivators. It was generally felt that the learning process can be enhanced in a number of ways by a variety of motivators. It seemed useful to classify the various motivators as follows:

A. Motivation based on the student's anticipation of the pleasure of achieving something solid (becoming a doctor, or graduating, or getting high marks) - a course constructed in such a way as to contain "relevance" would stimulate such motivation.

B. Motivation based on a regular feedback as to the effectiveness of the process (tests, marks, praise, respect of peers, etc.). Regular assessment would create this type of motivator, but the value of regular assessment was questioned by some.

C. Motivation based on the pleasure derived from the actual learning process itself (discovery, new knowledge and understanding). The course structure and content itself should create the motivation.

This discussion of educational motivators was considered important as a guideline for further discussion of method, content, and assessment. Constraints and conditions under which the course would be presented were then discussed. It was agreed that the course is to be for University of X, somewhere in Ontario, not for all the campuses of a "University of Ontario". The setting will be a normal Ontario university with at most minor improvements. The staff-student ratio for this first year course will be approximately what now prevails, i.e. about 100 students in the class which would have one professor devoting most of his teaching time to it and five part-time instructors, each giving about 5 hours per week to it.

There will be no more than 5 contact hours per professor per week, nor more than 120-150 contact hours in 25-30 weeks. The "best" teachers (whatever that is) in the department will be used for this and other first year courses. We can expect more timetable flexibility than is usually found. We can expect a good library and adequate TV playback

facilities, but not an elaborate TV production unit or a printing press.

On the second day, the group returned to the consideration of aims and objectives and felt that they should add to them by formulating what they called a "course philosophy". This philosophy was summarized as follows:

1. It should not be a survey course.

2. It must be conceptually difficult and must be known as challenging.

3. The general atmosphere must be one of guided discovery.

4. There must be much teacher (professor and instructor) involvement with the students.

5. It must be considered as one of the most important activities of the biology department.

6. The choice of content is completely irrelevant as long as it leads to the students' ability to gain a multi-dimensional overview of conceptual biology and provides the student with an opportunity to synthesize integrating principles. Any choice of subject matter should do. The actual selection should depend on what is of local interest, or of special interest to the professor or is perhaps available at lower costs in time or money thus freeing maximum resources for work with the student.

Group E decided that although the quality of the teacher(s) is one of the most important aspects of the success or failure of a course, good course design and optimal student input can minimize the chance of "bad" teachers spoiling the effectiveness of the course.

A course design should include as large a number of educational media as possible, in order to supply the student with varied kinds of stimulation.

The group recognized three basic kinds of educational process:

1. Unidirectional, uninterrupted (teacher-timed, no feedback), e.g. the delivery or public lecture or speech, an audio visual presentation or other scheduled performances such as panel discussion.

2. Unidirectional, interrupted (student-timed, no feedback), e.g. reading, library work on directed topic or laboratory work in open lab, project.

3. Bidirectional (co-timed, with feedback), e.g. a lecture with much questioning, tutorials, audio-visual presentation with questioning (professor of instructor present), laboratory and field work.

These three educational processes are included in the following types of teaching techniques. All would have a place in our course. The techniques their function and their role in our course were summarized as follows:

A lecture functions: to guide the student through a topic, to introduce him into the relevant situations, to stimulate his interest and convey to him the teacher's enthusiasm, to illustrate to him relevant scientific interpretations and generalizations, to bring him into contact with limitations and diversity in biological thought through the teacher's personal approach. Its role in present context is to build a framework of specific but related topics, to start the student thinking on a new topic of study. This may mean twice a week, or once a month, or irregularly whenever a lecture stimulus is considered necessary.

A TV programme or film can perform the same function as the lecture to certain sections of certain courses and for certain teachers. It can also be used in a laboratory setting. In our course it could be used to replace a number of or all of the lectures, depending on the aptitudes of the teachers and the facilities available.

The laboratory should provide exploration, experimentation, data gatherings, application of concepts; teaching in how to observe and how to ask questions; training in techniques of indirect observation and experiment; and it must allow the student to test models which were constructed in lectures, tutorials or in the lab itself. The labs must be linked closely to the lectures.

Reading teaches how to gain access to the printed information available in books and papers. This is so vastly greater in quantity than the absorptive potential of the student that this source of information must be selectively approached. We must teach students how to select reading and how to extract relevant information. A single "textbook" for

the course was considered inadvisable. Handouts or recommended readings should be rather more voluminous than the student can reasonably be expected to read. The student should, however, be expected to read 3-6 hours per week, to learn the use of the library, and to be able to discuss his reading in tutorial groups.

Tutorials. The student must learn to express himself, to criticise others and to cope with criticism himself. He must develop self-confidence. Here, the student is expected to integrate all component aspects of a topic within the topic, and with other topics. Tutorials should be held regularly. Tutorial leaders can be selected from 3rd and 4th year students in life sciences (ref. study by A. Worthington, Psychology Dept., Trent University, Peterborough, Ontario).

In summing up, we felt that the course would be centered on a series of lectures. Each lecture would introduce a topic. Relevant data could be collected in a laboratory session or in the field. The pertinent questions could be raised partly in the lecture, and partly by the students themselves in the labs. Further information can be extracted from a list of recommended readings and the synthesis of concepts and formulation of problems can be achieved in tutorials.

At this stage, the group re-examined the aims as set out on the previous day, and found that the above course structure can adequately fulfill these aims except for possibly the last one: "to develop the ability for self learning and independent thought".

At the beginning of the third day it was agreed that a discussion of assessment methods was the next step, and one which might throw light on the problem of self learning and independent thought.

The group agreed that the qualifying "gate" component of assessment may be necessary, but that its importance should be minimized. The important functions of assessment, that should receive an increased amount of attention, were considered to be:

1. a feedback to the student, giving him an indication of how he is doing.

2. a feedback to the staff, giving him an idea as to how his educational process is working.

3. as a possible motivator, but the risk of

undesirable psychological side effects must be recognized.

4. as a predictor of the student's future performance.

5. as a learning experience, i.e. through constructive criticism of performance.

Some of these objectives can best be achieved through a "final" exam, i.e. a lengthy examination at the end of the course; other objectives are best met through frequent tests.

The advantages of frequent testing were considered to be: more effective feedback to students; more effective feedback to staff (thus allowing corrective measures before it is too late); provides experience in being tested; a less tense assessment milieu; easier to utilize as a learning situation; more variability in testing method and situation and more effective as a motivator.

The advantages of final examination were considered to be: more reliable predictor for future educational success; provides incentive for integration and "overview"; can be either an alternative chance or a final chance.

In conclusion, the group agreed that as much variability in testing procedure as possible is a desirable trait of a course, that the feedback components should be stressed and that one should not be too concerned with trying to test all aspects of the aims of the course, since there appears to be a definite correlation between the different aspects.

For structuring of exams, it was less easy to achieve a consensus on such topics as choice on exams (open-book or not) and whether or not final exams should be optional.

A more detailed discussion of examination techniques was then held with 10 techniques of assessment being discussed.

The group finished this discussion by reviewing the aims of the course. It appears that the success or failure of fulfilling the aims could indeed be tested with the assessment methods which had been reviewed. However, a new aim was added to the list, viz. the course must develop the student's ability to communicate within the framework of the other aims.

A number of conclusions became apparent to the group when the content of the course was considered in the light of the previously stated aims. The most important by far was that a presentation of factual knowledge for its own sake would in no way contribute to the fulfillment of our aims. A careful consideration of this situation made us decide not to change the aims, but to accept the conclusion that biological facts would only become part of the students' learning experience in this course as a by-product of his exploration of the world of biology.

The choice of content, therefore, is of very little importance, and should be determined by such considerations as facilities and teachers, interests and aptitudes. The factual structure of a biological system is the educational medium, it is not the message.

The final stage of the Group E discussion was the construction of a module of instruction, based on our previously stated course-concepts. We decided to construct only one "module" (topic; unit; segment) of the course and to discuss briefly how the different modules might be integrated.

For the module we proposed to ask: how does it serve to fulfill our aims? how do we apply our teaching methods? and how do we assess its effectiveness?

The topic of the module was "why do ferns grow where they grow?". The kind of developments possible within the module can best be illustrated by listing a number of questions that can be raised in response to the title question and the topics which would be covered in exploring these. The question "what are ferns?" leads into concepts of identification, classification and diversity. The question "where do they grow?" involves a study of diversity of location and adaptation. "What limits growth?" would include a study of water; nutrients; physical and biological parameters of the environment. The question "what keeps ferns alive?" involves a study of how they reproduce and what is meant by the term "alive". "How do they grow and develop?" raises questions of how form and function and location are related to adaptation; evolution; structure and physiology.

Obviously, one could develop this module into an entire course of study; here, however, we felt that a first module in a first year course should be short. It should not try to answer all questions, and in fact should point out that a satisfactory answer to the lead question is impossible to get.

One way in which the module could be presented was then developed in some detail, i.e. accounting for the specific lecture, laboratory, tutorial and reading assignments which would need to be developed. If so presented, it would at least partly fulfill our aims and appears to be an acceptable beginning for the course. (see Appendix III)

Workshop 2 - Group D

Group D's reports were less complete than E's. This is in part due to the initial stresses within the group which slowed progress considerably. Whatever the reasons, it is difficult to review adequately the progress through various aspects of the systematic development of a course. There was, however, complete initial agreement in the group that currently offered courses in their own departments needed some changing especially in the area of the "careful consideration of overall objectives and of the ways in which the subject matter fulfills these objectives".

During the first day, Group D briefly considered objectives then put off detailed consideration of this topic in order to discuss Grade 13 biology in Ontario. This discussion led them to enunciate major content objectives. Later in the day, the group returned to a consideration of objectives and began to prepare a list.

The following day the group, now reduced by reason of the withdrawal of some members, began by stressing that unifying biological concepts were of primary importance when considering content and proceeded to list content topics in line with this objective. From there Group D went on to enumerate the constraints on their particular course and while doing this came up with the proposal that "the depth of subject matter should not be great". That is that the course would be something of a survey of biology.

The group then took time out to reconsider and to add to their list of objectives. The list prepared is not included here but it is perhaps fair to comment that about half of these were content objectives and the others were behavioral. No priorities were assigned to these objectives.

The remainder of the time of the conference was spent in the consideration of methods of assessment and importance of keeping assessment and evaluation in line with the objectives laid down for the course. A brief look at logistics wound up the third day's work. No report was submitted for the final half-day, although from the final summary it appears that the group rediscussed some of the

points raised earlier and finally joined with Group F. Group D indicated that the most valuable outcome of their discussions was the free exchange of ideas among delegates.

Workshop 2 - Group F

Group F began the first day with "a very frank and open discussion" on all aspects of a first year course in biology, including a questioning of the necessity of having one at all. This later view was prompted by a chemistry delegate pointing out "that a first year course which would attempt to deal with organic chemistry and biochemistry would be of little value without the students having had courses in such disciplines". As in Group D, they reported that "much was accomplished in this free exchange of ideas". Group F then went on to consider the role of survey courses and when lhey should be given and finally looked at objectives and strategies for achieving them.

Early the next day some members left to form the splinter group. A reduced Group F worked at clarifying their ideas of what the wide overall course objectives should be. These were listed but not apparently in any special order, although the group reported that they felt the fostering of an enthusiasm for the subject and an "appreciation of the importance of biology to man and to various disciplines of the life sciences" should rate very high on the list. From that point Group F plunged into the choosing of a "conceptual facet" for a content discussion: Inter-relationship was chosen as a theme and "Population Cycles" as a specific aspect of this theme.

The members discovered that "no matter where we decided to start, whether at the cellular level, the evolutionary level or the genetic level, we would eventually cover, in a superficial manner, the main ideas and principles inherent in the science of biology". Pursuing the topic of cycles, "they sketched out some ideas concerning content and operational tactics which they felt would be in line with these objectives, but this was not followed through in anything like the detailed outlined by Dr. Hawkridge.

Group F had been considerably increased in size on the third day when those who had remained in Group D joined with it. This made a difficult group to handle and late on that day exchange within the group became somewhat sharp. The group had indeed wrestled with its assignment to the point of near exhaustion and seemed to have covered about as much ground as it was likely to. The session for the final morning

was therefore cancelled and the group took the time to enjoy a field trip - a somewhat more relaxing and perhaps rewarding activity.

Workshop 2 - Splinter Group

As indicated above, early on the second day seven delegates from Groups D and F decided to form their own "splinter group" on the grounds that "Biology, Chemistry and Physics are not isolated subjects but students tend to treat them so as a consequence of the way they are taught. We need a course bringing together these subjects."

After listing four general aims of a biology course, the group laid down the assumptions from which they were going to work as well as some objectives concerning content. They concluded that their aims could not be fulfilled in one introductory course, but that there should be a core of biology courses each of which would serve as the sole course a student takes in that area of biology. They agreed that an introductory course in biology could bring together biology, chemistry and physics in an interdisciplinary way and fulfil their pre-stated aims.

Their next step was to discuss the content of such an introductory course and some points concerning methods. In these discussions they felt considerably hampered by the lack of chemists and physicists. It was decided that significant progress could only be achieved with representation of these disciplines. The latter part of their meetings was therefore devoted to the planning of a follow-up conference.

The final report from the Splinter Group to the May conference was a statement of their intention to meet later in the summer at the Queen's University Biological Station on Lake Opinicon to follow through with a systems approach to develop an interdisciplinary course including the preparation of a conceptual model and the designing of an actual unit or module.

At the Opinicon meetings in August an outline of a course called "Foundation Course in Science" was produced and also tentative plans for the systematic development of a trial course if financing could be obtained.

During their discussions, the experiences of the inter-disciplinary science programme at York University and the Open University's foundation course in science in Great Britain were examined and found to be interesting but not as

truly inter-disciplinary as it was hoped the proposed course would be. The group recommended, however, that various other attempts at an integrated approach should also be reviewed if wasteful duplication of effort is to be avoided. It was suggested that experiments in the directions envisaged by the group fail in the traditional university setting for political and personality reasons, rather than for pedagogical ones.

The course proposed as a foundation for the "scientist-technologist" should have Grade 13 chemistry and mathematics as prerequisites. Twelve contact hours of formal instruction per week were recommended. As a trial, the group suggested that 100 students should take part with a control class. The makeup of a trial course development team was outlined. A budget of $132,000 which would include a study of existing programmes, plus the actual course development, was drawn up. After consideration of the present cost of a student instructional hour, the group felt that, if the trial course is successful and the course adopted by a university, it would be no more expensive than a traditional programme over a period of a few years. If the course were used somewhere like the Open University, the cost could be considerably lower than for a traditional curriculum.

One member of the group advocated that the self-teaching of the integrated foundation course, i.e. reading, handling problems, writing assignments, etc., could be provided in exactly the same manner as the Open University, that is large mailed, written units and radio and T.V. lectures with tutorials. He felt that, as in Britain, it could be run from a centre for all participating universities. The student's progress through this part of his science training would be highly automated and would require little staff effort. The second part of his training would consist of intensive laboratory work and be staff-intensive.

The proposed outline for a "science foundation course" is not reproduced in full in this report but may be obtained from Dr. D. T. Dennis, Department of Biology, Queen's University or Dr. J. B. Armstrong, Department of Biology, University of Ottawa.

Clearly the splinter group developed some interesting ideas and enough enthusiasm to continue their discussion at a later meeting. By some criteria, they may have been the most successful group at the conference. Their critical examination of the need for the course proposed for development was entirely consistent with the approach laid out by Dr. Hawkridge. However, removal of those with certain interests from a group is in general inimical to the systems

approach. The stress that some wanted to put on the physico-chemical basis of biology might better have been kept in the deliberations of Group F. It seems clear to us, as Dr. Hawkridge pointed out in his address, that the viewpoint of the course team must be wide. A fragmentation into interest groups is not desirable for systematic planning of a course. However, given the problems of incompatability in Groups D and F, the separation may have been the best solution available.

Workshop 2 - Discussion

Of the four groups, Group E clearly managed to cover most in the four days of the conference. Indeed, they were able to cover most of the preliminary stages of the systematic development of a course in a balanced way. It is interesting that they paid very little attention to specific content, coming to it only on the third day and then rapidly reaching the conclusion that "the choice of the content, therefore, is of very little importance".

The other two groups in Workshop 2 made less progress though this is not to say that they made none. They reported considerable success and valuable discussions and reviewed, though in rather less clear cut ways, many of the stages of a system approach. But, clearly, they completed less of the assignment outlined by Dr. Hawkridge, and therefore clearly emerged with less experience in the systems method.

In the absence of Dr. Haynes who was unable to remain at the conference after the first day, Dr. Langford, a member of the planning committee, reported for Workshop 2 at the final plenary session. He pointed out that he had taken over only at the last moment, and could give only a very subjective picture of how the groups had worked, based on his participation in their discussions on the final day.

Dr. Langford outlined in some detail the work which Group E had done, beginning with a rigorous discussion of the plan for a course developed through the component sections of a systems approach. Having set out their objectives and constraints and general philosophy of their course they began on the single small topic "Why do ferns grow where they do?" By choosing a relatively small unit they were able to go beyond general considerations and to come to grips with the mode of presentation and many of the specific problems of teaching the unit. Dr. Langford felt that the group had become quite expert in the systems method.

He reported that Group D, on the other hand, had found early in their discussions that they had a wide divergence of opinion on how to approach the assignment and that they had finally agreed to disagree. Dr. Langford felt that this had been a wise decision. Group F, which became towards the end very large because of persons added from the fragmented Group D, found that it was difficult to contain discussion in such a large group. It had, however, worked assiduously at the topic of population cycles. This they had attempted to analyse and develop. But, partly because of the group size, and partly because of a lack of expertise on the systems approach, they had had difficulty. Dr. Langford felt that as a useful exercise in the systems approach this was less successful than it might have but that this did not imply that the participants had received no value from the excellent discussions. The "success" of a group could, as Dr. Langford suggested, be measured either in terms of the amount of training in the systems method which the participants received or in the value which they received from the many discussions which were fragmentary parts of the whole. Conceiveably these two types of success were reciprocally related and the preponderance of "anectode" which Dr. Hawkridge noted as opposed to a planned and disciplined approach may have been very successful in terms of exchange of viewpoints.

It is clear from the reports of the chairmen, from Dr. Langford's account at the final session, and from supporting opinions from a variety of persons at the conference, that Workshop 2 ran into more difficulties with its assignment than did either Workshop 1 or 3.

Because this conference is the first of its kind, at least in Ontario, the examination of such difficulties becomes important and the editors have therefore ventured to offer a somewhat tentative analysis of them.

The difficulties in a workshop could stem from any of three sources; the nature of the assignment, the selection and preparation of the participants; the procedures followed by the group within the conference. This last is clearly conditioned by the preceding two but is not necessarily determined by them and will be treated separately.

Workshop 2 had perhaps the most basis for agreement on content. Although Biology is not a highly hierarchial subject, there has come to be widespread agreement on what topics are best taken first. On the other hand, it is in the training of future professionals that the special, and indeed vested, interests lie, and this is a counter force which was revealed in two of the three groups of Workshop 2 as being

stronger than any traditional framework. In retrospect the assignment for Workshop 2 had latent problems which the planning committee had recognized but had failed to guard adequately against.

The selection and preparation of the delegates has been discussed elsewhere. It was less than ideal but quite adequate to have prevented the problems which showed up so clearly in Groups D and F. The conclusion is hardly escapable that it was primarily in what went on in these groups at the conference which resulted in their relatively modest progress on the assignment given them.

It is not to be expected that all groups at such a conference will succeed equally well. As Dr. Hawkridge pointed out in the first plenary session, some people are by temperament well and some ill suited to the kind of work the conference was attempting. Inevitably there would be, by chance, some concentrations of persons who could not work well in this system and such concentration would be disrupting. This may have been a factor.

Yet, most of the evidence from the reports and from discussions suggested that these factors were not the chief explanation for only modest success. The limited success of Workshop 2 appears to have been due to the following:

1. Groups D and F, and in a more restricted sense the splinter group, allowed themselves to become preoccupied with content. The content discussed differed widely between the groups but all were heavily content-oriented. This was in spite of the fact that Dr. Hawkridge warned against too much attention to content at early stages in the planning and the schemes presented in the preparatory material emphasized that selection of specific content came rather late in systematic development.

2. To the extent that "objectives" were examined the less successful groups tended to concentrate on general aims rather than moving on to more precise operational objectives.

3. The groups which had most difficulty appeared not to have realized the iterative nature of the process. Blockage on one point should not be allowed to develop. Instead the difficult point should be quickly resolved in a tentative way pending consideration of other issues. On a recycling, it may turn out not to be contentious. The most successful groups cycled this way between objectives and procedures or strategies a great many times in the first few days.

4. An essential feature of the systems approach is that it is a disciplined argument towards an optimum procedure. The main features of process were laid out in the preparatory material. These had been prepared by acknowledged experts and problems arose repeatedly when the discipline inherent in the schemes was ignored. Most groups recognized this. Some of the groups in Workshop 2 apparently did not.

The essential problem of Workshop 2 was then that too large a proportion of the participants had either not absorbed or would not accept the principal methodology of the systems approach. Moreover, the opening address to this group did not reinforce the keynote address as did the opening addresses to the other workshops and the workshop leader was unable to stay for the conference. Dr. Hawkridge gave what help he could but this was limited and the chairmen were left essentially on their own to wrestle with a difficult task made more so by the various considerations discussed above.

The majority of the factors producing the problems of Workshop 2 were beyond the control of any one group or person. The topic involved the vested interests of the participants in particular aspects of the discipline. The topics of other workshops emphasized the interests of the participants as teachers rather than as recruits to the sub-specialties of the profession. The fact that this workshop was the most popular might have served as a warning of this. The organizers of the conference might also have noted that the teaching experience of those expressing interest in this workshop was only about half that of the other groups (about 8 years against 15). It is well known that older teachers have more generalized interests. With some premonition of the difficulties, steps might have been taken to increase the amount of expert assistance. It is not surprising that these things were missed in the considerable rush of convening the conference but for any future conference of this type the problems of Workshop 2 should be considered very carefully.

WORKSHOP THREE - Design of a Short Instructional Unit

Introductory Address

Modules and Minicourses

W. H. Dowdeswell
Bath University

Throughout universities in general it is probably no exaggeration to say that the majority of undergraduate biology courses tend to be organised on a linear and sequential plan. Although the amount of time allotted to particular topics varies greatly, the span of any one course will seldom be less than half a term and is frequently longer. The limitations and shortcomings of the traditional lecture system employed in presenting these course materials have been the subject of numerous reviews and need not concern us here. Suffice it to say that such courses have all too often evolved with scant regard for educational objectives and with an emphasis on the problems of teaching rather than on those of learning. As a teacher, it is all too easy to delude oneself into imagining that a sequence which seems logical in a teaching content will prove equally so to a student, or that an idea generated in one set of circumstances will automatically be carried over and applied in a kindred situation. All of us at some time or another, will have encountered the fruits of such misconceptions as revealed, often with painful reality, in students' examination scripts.

Partly under the catalytic influence of the rash of curriculum development projects which have recently erupted in schools, many universities are now beginning to scrutinise their teaching anew, not only from the point of view of content but also in terms of educational aims. In this new thinking, one of the most important realisations which is only just beginning to gain ground is that, if any progress is to be made towards a more effective learning system, attention must be concentrated on the needs and responses of the learner rather than on the attitudes and notions of the teacher.

Thinking along these lines had led to the concept of a modular approach to teaching; instead of presenting an area of

knowledge as a single continuous course, the subject matter is split up into a number of self-contained sub-courses. That this idea has already achieved fashion proportions is indicated by the fact that what is now known as a teaching module in Britain, is variously described as a "minicourse", "microcourse", "concept-o-pac", "instruct-o-pac", "unipak" or "concept set" on the other side of the Atlantic. In the following account I shall restrict usage to the terms "module" and "minicourse", which can be regarded for all practical purposes as synonymous.

The essential features of a minicourse can be summarised as follows:

(a) it covers a limited and coherent range of subject matter and ideas. Some typical biological examples might be "Enzymes" or "Transport Systems".

(b) it may last from 15 minutes to 15 hours.

(c) the objectives of the course are stated clearly at the outset.

(d) it may be accompanied by a diagnostic pre-test the result of which enables the tutor to determine whether the student is in need of the course (e.g. to ensure that he does not know the material already) and if so, whether he possesses the requisite background knowledge (e.g. in chemistry) to profit from the module.

(e) the work is largely self-instructional but closely integrated with tutorials, supplementary reading and, where appropriate, laboratory work.

(f) a full range of teaching media is used such as audio-tape, transparencies, 8 mm film loops, programmed texts, diagrams, models and specimens in a variety of combinations, according to circumstances.

(g) the same module may make use of several different teaching media, or the same medium employed in a number of different ways. Such a diversified approach is the essence of all good teaching and is particularly important for longer sequences in order to avoid boredom and to maintain motivation in the student.

(h) a post-test enables the student to evaluate the success of his learning and the teacher to assess the effectiveness of the module in terms of the stated objectives.

Roles of minicourses

The old adage that there is nothing to beat a good teacher may well be true. But good teachers are scarce and their time scarcer still. When used in appropriate circumstances, minicourses can take over many of the more routine tasks of the tutor thus freeing him for personal contact with the students, which remains an essential ingredient of the learning situation in universities.

Using in part the system of classification adopted by Postlethwait and Russell, we can enumerate the principal advantages of minicourses compared with a conventional approach:

(a) The quick pre-test helps to ensure that a module will meet the requirements of a student and that he is in a position to profit from it.

(b) Objectives are clearly stated in terms of student performance and changes in attitude. The pupil therefore knows what is expected of him before embarking on a particular piece of work.

(c) Their design is orientated towards the needs of the learner in providing a combination of learning experiences presented in an integrated manner.

(d) The role of the teacher is no longer as an expositor but rather that of adviser, diagnoser, prescriber and motivator.

(e) With self-instructional materials, each student can proceed as he likes. He is free to omit any portions that he already knows and to repeat others that he may find difficult.

(f) In a short module it is possible to utilise a variety of media and teaching approaches which would be impossible in a lecture. Clearly, the simpler the media used, the wider will be the range of circumstances in which a minicourse can be studied. Thus a sequence employing audio-tape/transparencies/programmed texts could be used at home, whereas one including film probably could not.

(g) While minicourses are usually highly individualised, some can also be used for group instruction. This is particularly true where the learning of techniques is involved.

(h) The student is actively involved all the time and his learning derives from his own participation.

(i) The design of materials supplementary to a particular module is relatively easy. In this way the the needs of the able student for extension work and of the slow learner for remedial help can be met equally effectively.

(j) Students can work each at his own rate and spend as much time as is necessary to master a topic. The principal limiting factors are the availability of module materials and the overall time tabling within the establishment.

(k) Minicourses provide for greater flexibility in times and places of study, subject to the limitations mentioned in (f) above.

(l) They can be constructed in a great variety of patterns to conform to different approaches and themes.

(m) The post-test enables a student to evaluate quickly his success in mastering a short sequence of work. Should he fail he need only repeat a single module. Failure in one or more minicourses need not therefore mean failure in the course as a whole.

(n) The post-test also points to deficiencies in the course materials themselves, in as much as they may fail to enable students to attain the stated objectives. Such shortcomings are inevitable particuarly during the trial period, but they are relatively easy to pin-point and rectify in a short learning sequence.

The minicourse approach thus represents a radical departure from tradition in aiming to provide the maximum opportunity for independent study. In so doing, it places responsibility for learning squarely on the shoulders of the student. As we saw earlier, the emphasis throughout is on learning rather than on teaching, the activities of the student being or primary concern, rather than those of the tutor. Given this degree of freedom, one of the biggest problems likely to arise among students is the continued maintenance of interest. This is particularly true of extravert personalities who tend to be less motivated than introverts and hence to need more powerful and frequent stimulation. This can be achieved in varying degree partly through the diversity of the materials themselves and the

width of interests that they succeed in satisfying, and partly through personal contact with tutors. The contribution of these self-instructional modules to learning is thus complementary to that of the teacher and in no way a substitute for him.

Problems of design and implementation

The situation at Purdue University, Indiana (U.S.A.) on the one hand and the Inter-University Biology Teaching Project in Britain on the other, represent two extremes of what is now a fairly wide spectrum of investigations into the possibilities of a modular approach to learning. The work of Postlethwait and his colleagues in pioneering the Audio-Turotial Approach in the Department of Biological Sciences at Purdue needs no introduction and is admirably documented. Suffice it to say that following the introduction into the freshman botany course in 1961 of audio-taped materials, a complete self-instructional system was evolved during the next ten years. This necessitated not only the development of appropriate learning materials but also the design of carrels for self-instruction provided with the requisite audio-visual equipment and other facilities. The desirability of introducing minicourses at Purdue has stemmed more recently from earlier experiences, the intention being to use them for the core programme in undergraduate biology. Thus a student may have the option of completing say ten out of a total of fifteen or twenty minicourses in order to meet the requirements of a single main course.

By contrast, the five British Universities (Bath, Birmingham, Glasgow, London, Sussex) involved in the Inter-University Biology Teaching Project are exploring different ways in which modular materials can be used in conjunction with more traditional teaching methods. It is hoped that the new materials and the thinking associated with them, will provide a stimulus to others to view their teaching syllabuses more critically, together with the educational objectives on which they are based.

So far, we have identified three different areas in which minicourses are likely to be of value:

(a) Bridge courses. These are intended to span some of the notorious gaps between knowledge acquired at school and that needed for first year university work. Some typical topics are "Development" and "Genetics". These courses could also be used in the universities for remedial purposes but they are not intended primarily for this purpose.

(b) Technique courses. These are concerned with the acquisition of essential skills which, at present, demands repeated demonstration by a lecturer or technician. The modules are suitable for group teaching as well as for self-instruction, some typical examples being "Aseptic Techniques" and "Electricity for Biologists".

(c) Main courses. The main course is a kind of module which appears to approximate most closely to those in use at Purdue University, and is intended to form part of a larger university course run on traditional lines. Thus, a module on "Enzymes" could be used in a wide variety of contexts, such as botany, zoology and biochemistry.

I suspect that relatively few universities are likely to find themselves in the position of Purdue and be able to turn over a complete segment of teaching to a self-instructional approach. Evolution is a lengthy process and in education, more than any other branch of human activity, it seldom pays to cut corners. The situation in Britain at the moment is likely to be fairly typical of many universities who may choose to explore the possibilities of minicourses. Since the I.U.B.T.P. materials have yet to appear on the market, I can do no more than outline some of the problems of implementation that are likely to arise without providing any of the answers:

(a) to what extent is it possible to integrate self-instructional materials with traditional course work? Technique courses would seem to present little difficulty; individualised modules (Main course) obviously raise greater problems.

(b) how do we construct a departmental time table so as to accommodate traditional teaching as well as the use of minicourses?

(c) can we make use of traditional laboratories and teaching spaces without substantial modification for a limited number of minicourses, or are separate learning areas equipped with study carrels essential?

(d) to what extent can self-instructional modules be used by students away from the university premises, for instance in their lodgings?

(e) what is the capital outlay involved in introducing minicourses on a partial or total basis, say for 100

first year students?

No doubt there are other problems that I have overlooked, some of which may be peculiar to Canada.

Contributions of educational technology

We hear a good deal these days about educational technology and its potentiality for changing the learning scene for the better. Certainly we have so far seen all too little of such influence in the universities. Part of the trouble, I feel sure, derives from a mistaken idea that educational technology is solely concerned with various kinds of "hardware" intended for the production and delivery of instructional materials. In fact teaching, like much of medicine, is itself a branch of technology, and the setting up of the "software" for a learning situation is just as much a part of educational technology as are tape recorders and projectors. One of the dangers we all have to face at present is that hardware technology will outstrip that of software so that the two become dissociated to the detriment of the learning situation that they are both attempting to serve. In the Inter-University Biology Teaching Project, if we have learnt one lesson above all others, it is that the production of a successful minicourse is far more complex and time consuming than appears at first sight. It has been stated on occasions that from conception to final completion may take as long as five years; certainly three years is not an over-estimate.

The sequence of developmental stages can be summarised schematically as follows:

Pre-test → Objectives → Learning Materials → Presentation → Post-test

One of the advantages of working in a university is that student volunteers are often forthcoming who can be used for testing sections of minicourses as they are produced. This can be a great saving in time, enabling an element of re-writing to be carried out before the module appears in toto. Even so, experience shows that further modification is likely to be needed in the light of subsequent class experience.

The theme underlying the preceding pages has, I hope, been clear, namely that a much more systematic approach to curriculum development is needed in universities. Educational technology utilised to the full can undoubtedly play a vital part in bringing about a situation in which the teacher ceases to be an expositor and becomes the manager of a learning system while the pupil ceases to be a mere recipient and becomes actively involved in his own learning process. In this purpose of change minicourses undoubtedly have an important role to play, not only as learning materials in their own right, but also on account of the stimulus they can provide for the review of traditional syllabuses in the light of the objectives they are seeking to achieve.

References

Adamson, H. and Mercer, F. V. (1969) A New Approach to Undergraduate Biology, Macquarie University, Australia.

Beard, R. (1970) Teaching and Learning in Higher Education, London, Penguin.

Bloom, B. S. et al (1956) The Taxonomy of Educational Objectives, London, Longmans.

Dowdeswell, W. H. (1970) Inter-University Biology Teaching Project, Journal of Biological Education 4, 197-203.

MacKenzie, N., Eraut, M. and Jones, H. C. (1970) Teaching and Learning. An Introduction to New Methods and Resources in Higher Education, UNESCO.

Postlethwait, S. N., Novak, J. and Murray, H. T. (1969) An Audio-Tutorial Approach to Learning, 2nd ed. Minneapolis: Burgess Publishing Co.

Postlethwait, S. N. and Russell, J. D. (1970) Minicourses - The Style and the Future, Department of Biological Sciences, Purdue University, Indiana.

Review of Workshop 3

There were two groups working on the problem of Workshop 3 - the development of a short instructional unit. Each group was free to choose the topic of its unit and the amount of instructional time it would fill. Group H chose "Ventilation and Respiration". Group G chose "Pollination", (perhaps prompted by trees in bloom which arched over their meeting place). The deliberations of Group H will be presented in some detail, session-by-session, followed by a briefer description of the proceedings of Group G. The general outline of the work of these two groups is summarized in Table 5.

Workshop 3 - Group H

Group H began by defining a few of the constraints under which they would work. These were that they would design a mini-course to last one week (10 hours per student), to be used on campus, to be levelled at the first year, to include a pretest of previous knowledge, to be suitable for a majority of Ontario universities and to include both plants and animals. Aims and objectives were at this stage outlined "in the haziest of terms".

Much discussion centered on the pretest of prior knowledge and it was agreed that this should include testing for knowledge of the gas laws, for the principles of diffusion and for the understanding of surface to volume relationships. Remedial material would be part of the course as necessary.

A "doodle" was made of the major topics within the general outline, taking the gas laws as the central topic. This was then abandoned.

A course outline was drafted in narrative form. It was decided not to treat cellular respiration but to regard the cell as a black box. Similarly, blood would be regarded as a black box and assumed to be the starting point for the succeeding module. The outline of the unit as developed to this stage was therefore:

Title: Gaseous exchange and diffusion - problems of size and shape.

Pre-test: Gas laws. Diffusion, surface/volume relations (remedial material).

Starting Point: What is air? Solution in aqueous

Table 5

WORKSHOP 3

Day	Group G	Group H
Monday 17th	Constraints Objectives Possibilities of content Working scheme - content and method	Constraints Aims and objectives broadly outlined Pre-test Course outline
Tuesday 18th	Development of method	Return to general objectives Method Discussion of assessment
Wednesday 19th	Re-define objectives Preparation of outline of module including content and methods and assessment	Review of objectives with emphasis on making them operational Priorities in objectives Preparation of short sections by sub-groups and comparison with objectives of original outline
Thursday 20th	Preparation of criticism of groups work by three members	Preparation of short sections by sub-groups and comparison with objectives of original outline Final report assessment Discussion of possibility of inter-university cooperation

medium; interface/membrane; CO2 and O2 both.

Main Part:

Single cell, diffusion, temperature; cell-black box; include algae, photosynthesis and respiration; cell size and shape; queerly-shaped cells, eggs, differences in design.

Surface/volume ratio, model, enlargement, thin plate strand, etc.; egg development. Holes in organisms, honeycombing, diffusion in large creatures, insects and leaves (water conservation).

Pumping of air, insects (no blood, circulation of oxygen), lungs, "hyperlung" of birds. Oxygen into blood and pumping of internal liquid (branching point to next module).

Pumping of blood, heart, dissolved oxygen and carbon dioxide.

Pumping of external liquid, gills, counter-current; super-pumping and ramjet - sharks or mackerel and squid.

Members agreed that it was important to avoid academic display.

Enrichment Material, which was suggested as appropriate, included medical aspects such as a heart-lung machine; air pollution and emphysema; diving physiology, yoga, physical education and aerobics.

On the second day the group returned to a consideration of their objectives. They concluded that all their attempts to clarify objectives had proved quite unsuccessful and objectives had been drawn up thus far in only the most general of terms.

In an effort to get nearer to defining objectives, the group decided to consider in some detail the way in which a ten minute segment of the proposed unit might be presented. This was preceded by a short discussion as to the media and techniques of presentation which might be adopted. A frustrating one and a half hours was spent deciding on just which ten minute segment should be discussed further. They finally chose that portion of the programme which would deal with the consequences of increase in size of single cell and of possibilities of change of shape. The means by which the concepts could be presented were discussed.

After considering once more the objectives, they turned to the question of assessment and decided that probably a three stage method of assessment might be most successful. Stage one would consist of a series of multiple choice questions, perhaps computer marked, to test recall and simple problem solving. All students would take this test which would give a grade no higher than "C". Those who wished to try for a higher grade and had obtained a "C" on this test would then be eligible to take the second stage which would be more complex problem solving and would probably have to be hand marked in some way. The third stage would be designed to test for synthesis and communication and would take place at the end of the whole year's course. Only those students who had achieved adequate standing in the second stage tests would be eligible to take this test which could raise a student from a "B" to an "A" grade. This model of assessment provoked a great deal of discussion which continued throughout most of the conference. Sample questions were written for the first stage of the examination.

On the third day, the group returned once more to the objectives of the course and produced a brief list, chiefly non-operational. The suggested objectives included:

(a) to present the fundamental biological concept of respiration,

(b) to present the fundamental biological concept which is expressed in the title of the unit.

After some discussion, what is perhaps a more important objective was expressed as "reinforcing the overriding objectives of the whole full course of which this unit is a part (e.g. scientific method, etc.)".

At that point the group decided to consider the operational objectives of the one small ten minute segment which we had previously considered in detail. Much effort was spent on drawing up two successive lists of operational objectives of this segment and the second list appeared to be truly operational. They then drew up a chart to compare the expressed objectives with the methods they had chosen and considered the media which might best serve to fulfill each of the objectives. The match was quite good. It was noted that although at present it might be best in some contexts to use film loops, supported by audio tapes, it is likely that within three years time this could well be more economically substituted by video-tape cartridges.

The group then discussed the hierarchical nature of the operational objectives, noting that although such an objective as the inculcation of the scientific method is clearly an overall objective of the whole course of which this unit is to be a part (as it is for all courses in science) it must still remain an objective of any single unit within the course. This appeared to be best expressed by some such statement such as, "reinforcing the over-riding objectives of the whole full course of which this unit is a part (e.g. scientific method, etc.)".

The group then divided into three sub-groups each of which took one portion of the conceptual scheme which had been worked out for the module on the first day and prepared a draft version of the instructional material. The drafts included a sample of the portion of a tutorial book, a tape and a general outline of the media to be used together with a block diagram of concepts, an indication of sections that needed illustrative, reference or enrichment materials. A slight mismatch between the expressed objectives and the draft course as produced indicates that another cycle of iteration is required to perfect the module.

The group as a whole felt that the three tier system of assessment discussed earlier is attractive both in supplying feedback as to how successful the module has been and in serving as a screening process whereby only those students who wish to aim for a high grade need be examined in full.

On the fourth day the group reviewed their work of the preceding three days and considered some of its implications especially in relation to the preparation of teaching materials. In their final report Group H made the following statement:

"Group H has been exploring the possibilities of interuniversity cooperation in the production of modules for incorporation in existing first year courses. We would like to make a recommendation that a pilot project be set up whereby several cooperating universities identify which parts of their courses are more or less equivalent. A module for each part should then be prepared at one of the collaborating universities and be made available for use by the others. There should be no question of publication of these modules so that copyright problems can be escaped. In order to make such a scheme work, hardware should be standardised at the lowest possible cost.

"Such a scheme would serve as a pilot project not only for Biology but for other foundation courses throughout the universities of Ontario and the group would therefore like to request that this conference propose to the Council of Ontario Universities and the Committee of University Affairs that the CUA should fund such a pilot scheme. We also suggest that an ad hoc committee be formed of some of those members of this conference who feel prepared to commit themselves to such an interchange to guide its progress."

Workshop 3 - Group G

Group G decided that their unit on pollination could be initially directed at grade nine level students, and then, if need be, adapted to higher levels by adding new units.

After deciding upon aims and objectives for the unit, they discussed the possibilities of content within the topic.

A first draft of the working scheme for the module was prepared. Both content and methods were incorporated. By the end of the third day the group had completed an outline draft for a module. The form of this module is presented here in a considerably abbreviated form.

The objectives of the module were stated as:

1. to be able to state in no more than 200 words what is the importance of pollination in the evolution of plants.

2. To be able to describe the basic process of pollination.

3. To understand how different flowers are adapted to wind and insect pollination.

The instructional unit and related tutorial were to be concerned with the process and mechanisms of pollination, and the role of pollination in the survival and evolution of plants. Material covered would include an examination of those flower structures which are involved in pollination, the ways in which different flowers are adapted to wind and insect pollination, and the meaning of cross and self-pollination. The tutorial would be expected to reveal to the student the biological significance of pollination.

A full outline of the module was then worked out with an indication of how each part would be presented. An introductory section dealt with the nature of sexual reproduction and related this to flowering plants. A

laboratory exercise involving analysis of the floral parts concerned in pollination followed. The student was then introduced to different types of flowers illustrating wind and insect pollination. There was also a factual or laboratory part of the module. A section on cross pollination led into a discussion of the molecular basis of species specificity. A tutorial was then included and following this a post-test.

Some members in Group G felt that although they had had some success in producing an instructional module, there had been notable deficiencies in their approach. Three members prepared a memorandum which they submitted as a postscript. This said in part:

"This group notes with regret that the "short instructional unit" team was unable to consider a framework of educational philosophy for its deliberations. Moreover, the techniques of learning psychology - especially behavioural objectives - were neither sufficiently studied nor applied."

The memorandum went on to say that course units, like Pollination, could effectively present content and concept. For instance, this unit could be used as "a model to illustrate basic biological concepts such as variation and survival". Commenting on objectives they felt there should be one broad objective - "to illustrate the role of pollination in survival of species" and then a list of more specific objectives. The memorandum continued:

"We are convinced that student feedback is critical to the success of learning modules. It is a grave error to assume that a course creator's objectives are adequately stated or sufficiently understood. They must be examined in detail, critically, with student help - and clarification or revision of objectives should be considered a necessary development step.

Finally, the group is concerned with our reluctance to analyze our roles as educators and our preference for specifying our profession solely as biologist."

The chairman of Group G, after considering all the workshop reports, produced the following "Recommendations of Group G".

1. Mini-courses can be the best system for certain types of knowledge acquisition.

2. A mini-course BANK should be established for first year level courses.

3. A mini-course BANK should be established for highly specialized advanced courses by specialists of one university for use by all others.

4. A completely equipped fully staffed centre for mini-courses should be established to which expertise is co-opted.

5. Given such a Centre for Instructional Development a mini-course PILOT PROJECT should be a priority item. We feel that this would be the proof necessary "to sell" the concept.

6. We believe that the mini-course can, among other things, satisfy basic information needs and thereby release the professor for a better use of his time, such as concept development.

7. Provision should be made for a greater number of professors to participate in workshops of this type.

8. In such groups more student participation would be desirable as would the presence of non-specialists.

9. Means should be found to convey information to one another after we have returned to our respective universities.

10. We feel that there should be another meeting of those participants who would like to pursue this concept further.

Workshop 3 - Discussion

One of the most interesting outcomes of the workshop developing a short unit of instruction was not only that they progressed further than did other groups - for example getting much closer to a complete system of objectives, presentation and evaluation - but that the concept of teaching materials prepared as short modules was so well received. In assigning a short unit to Workshop 3 the Planning Committee had been concerned really only with limiting the size of the assignment so that the process of design could be more complete. There was, of course, some invitation to look at modular or mini-course instruction implicit in the topic and this was reinforced by having both Mr. Dowdeswell and Prof. Mercer who had spent considerable time on development of such modules, in

the group. Nonetheless, the general interest in modular instruction (which appeared also in Workshop 1) is a striking result of the conference.

One implication of this support for modular instruction is that the groups considered biology rather less hierarchical than most biology teachers tend to think. We can, therefore, at least in the present state of this science, develop programmes which are more flexible than those we have been using. One price for modular instruction is, of course, that preparatory and remedial materials must be available. The problem of providing these clearly did not strike the participants of Workshop 3 as unsurmoutable.

As indicated in the description of this work Group H showed clearly how an initial frustration could be cleared up when the iterative nature of the process was accepted. Group G progressed to a definition of its objectives rather more quickly than did Group H, but found that it had to reconsider and redefine them a number of times. From the report it appears that the group also followed a number of cycles through objectives and methods but that these were closely related to the development of content. The iterative quality of the process was perhaps not quite as obvious but was present and apparently effective.

Mr. Dowdeswell gave the following report to the final plenary session as his evaluation of Workshop 3.

Design of a Minicourse

The activities of the workshop followed closely the original aim, namely to design a short instructional unit suitable for a wide range of application.

The preliminary discussion of possible objectives soon showed that any attempt to design in 4 days a minicourse of, say 15 hours' duration, was out of the question. It was therefore agreed that, at most, it might be possible to establish the outline of a small section of such a course lasting approximately 45 minutes. Each of the two groups selected a different topic. Group G - Pollination (part of a larger module concerned with Plant Reproduction and Survival) and Group H - Size and Shape (part of a course on Respiration and Ventilation).

In their discussion the groups attempted to conform to the sequence:

(a) Justification of the need for a particular course

(b) Statement of behavioural objectives

(c) Setting up a conceptual plan

(d) Working out methods of presentation

(e) Preparing pretests and post tests.

It soon became clear that although such a sequence of activities appeared simple in theory, it was far from easy to carry out in practice. In particular, a precise statement of objectives proved to be a formidable stumbling block. In order to overcome the periodic impasses that occurred and also to make the most of the short time available, it was decided not to spend too long on any one phase but rather to refer back frequently to previous deliberations in the light of later findings. As a result, discussion in both groups tended to oscillate to and fro, the end product almost invariably being a reconsideration and further clarification of behavioral objectives. That this policy was the right one is amply evidenced by the fact that both groups succeeded in producing workable outlines of learning sequences and, to some extent, test materials as well.

Lessons from Group Activities

As a result of 4 day intensive work certain important lessons emerged. None of these is new to the field of curriculum development, but they are worth summarising nonetheless in the parochial context of the conference.

(a) Once the need for a particular module has been established, its preliminary development is best undertaken by relatively few people (about 3) who are of like mind regarding the broad aims involved and the procedure to be pursued. The lavish, consumption of time by both groups in discussing objectives during the first two days was due in large part to their size (approximately 12).

(b) In the initial stages of planning a module, a precise statement of objectives can be exceedingly difficult. Subsequent activities such as the drawing up of a conceptual

plan and method of assessment can help to clarify an earlier statement.

(c) In the course of deliberations it is desirable to take stock of the situation at regular intervals, if possible in the form of a brief written report prepared by the chairman of the group. Such reports can be invaluable in helping to coordinate the thinking of the group.

(d) When deciding on methods of presentation, it is essential to take into account the range of resources likely to be available to all possible users.

(e) No satisfactory means of assessment can be decided until the behavioural objectives have been clearly stated.

(f) To be acceptable, an objective does not necessarily have to be assessable. This is particularly true of changes in attitude.

Minicourses - Justifications and Implications

In addition to the group activities outlined above, discussion also took place of broader issues, the most important of which are as follows:

(a) The effective production of minicourses (including their evaluation) is expensive in human time, expertise and technical resources. In order to increase efficiency and reduce costs to a minimum, there is a strong case for setting up a few centres which are fully equipped with the necessary technological facilities - the hardware, technicians and educational technologists to provide assistance with procedures such as programming. Such centres would be used by several universities and members of staff could be seconded for periods of say 2 years.

(b) It is sometimes asserted that modular learning is impossible without the provision of permanent carrels involving high capital expenditure and the exclusive use of valuable space. This is not so, satisfactory carrels can be constructed which are portable, inexpensive and easily stored. Hence, a laboratory used for minicourses can be employed if necessary for traditional teaching as well.

(c) The introduction of minicourses can be justified on grounds of expediency and the contribution they can make to

the overall flexibility of a biology course, both in its presentation and the opportunities it provides for more effective learning. They can also lead to a better use of tutors' time (but probably not to a saving in manpower).

(d) Minicourses can also be justified on educational grounds as being the best way so far evolved of presenting certain kinds of learning materials. The challenge for the future will be to determine how they can be integrated into programmes which utilise traditional teaching methods as well.

(e) In the long term, perhaps the most profound outcome of modular instruction will be its effect on the position of the tutor vis a vis his pupils. In the lecture and, to some extent, in the small group discussion the relationship is essentially a private one. A modular approach at once changes the position of the teacher from that of an expositor to the more prosaic and public role of adviser, diagnoser and motivator. An inevitable outcome of such change is that tutors and pupils will be brought closer together - to their mutal benefit.

EVALUATION, IMPLICATIONS AND RECOMMENDATIONS

The final plenary session was devoted to preliminary overall evaluation of the conference and consideration of its implications for university teachers, university teaching and for the Ontario university system. Discussion relating to specific workshops has been reflected in the previous section. This section of the report begins with the text of Dr. Hawkridge's assessment. It then expands on some of his points to provide a more detailed evaluation of what went wrong and why, as well as what went right. From what was learned from the planning and conduct of the conference, the editors derive several recommendations which are outlined at the end.

Dr. Hawkridge spoke as follows:

The classical form for evaluation is an examination of the stated objectives and the extent to which they have been achieved.

The Steering Committee enunciated six "Purposes" in the documents prepared for the Conference, and Dr. Good included three "Objectives" in his initial paper. I shall take each in turn.

Stated Purposes

(a) To introduce the participants to the concepts and methods of the systems approach to curriculum planning.

This objective was fully accomplished, through both the keynote address and the other papers on this topic that were circulated. No member of the conference lacked introductory information on this topic.

On the other hand, the introduction did not give all a complete understanding. Some may have felt that such an approach was out of character for them, as they consider

themselves more as artists than technologists. Others may not have felt persuaded that the systems approach was necessary in their own situation. Still others may have felt the need for further practice and examples.

(b) To involve the participants by having them work in small groups on particular objectives.

This objective was fully accomplished as far as involvement was concerned. There were few if any who did not participate. Some found that involvement was painful. Each of the groups seemed to pass through phases, some slowly, others more quickly. In the first phase, individuals were constantly trying to relate what was being said to their own experience (a kind of exploring, territorial behaviour?) and the result was a good deal of anecdote. These conversations were interesting, and probably quite valuable to participants in many cases, but they did not contribute directly to the achieving of the stated purposes or objectives. From time to time, the conversations reached a low ebb, however, and served little good purpose. Different groups rapidly acquired their own characteristics, and some were far less productive than others.

Perhaps part of the fault lay with the "particular objectives" set for each group. Certainly some felt that their instructions had not been clear enough. On the other hand, directives are disliked by academics generally, and they often prefer to be given the chance to formulate their own objectives. It may be largely a matter of personality.

(c) To familiarize the participants with the problems inherent in the systems approach by means of the small working groups.

This objective was only partially accomplished. Some groups really did not work on the systems approach at all, but launched upon long rambling discussions centred around content and only occasionally touching on methodology, in a general way.

These groups that did look at the systems approach and that tried to employ it certainly met the problems! These were problems in defining the components of each course "system" and in establishing their interrelationships. For example, problems were encountered in designing student activities that were directly related to both the objectives and the assessment for a unit or module.

(d) To equip the participants with ideas and

experience which may be expanded by them in the context of their own departments.

Here, accomplishment of the objective is a matter of degree. Probably everyone learned something, but in terms of cost-effectiveness perhaps one-third may have wasted their money so to speak. Pay-offs for individuals varied very widely in both nature and content.

The objective might have been made more specific. For example, since writing objectives themselves is difficult, the Steering Committee might have asked for a training session on writing objectives for biology.

(e) To produce a report of the proceedings, including perhaps recommendations for implementation of programs developed in the workshops.

This objective will be accomplished by the Steering Committee in due course. The recommendations will depend largely on which modules or units are brought to proposal stage. A recommendation for an interdisciplinary science workshop in August may result from the "Splinter Group".

(f) To develop guidelines for future workshops in biology or other disciplines.*

This objective was not achieved, unless the "Splinter Group" work can be counted. The Group did not really develop guidelines so much as suggesting that they would employ various procedures to propose and justify a course of action.

Good's Objectives

(g) To examine the proposition that system and cooperation are indeed interdependent.

Good himself pointed out that this objective was very broad. Certainly most participants felt that cooperation was necessary, but it was hard to judge whether they came to the view that system and cooperation were interdependent.

(h) To provide a training ground in systematic course development.

This objective was accomplished, at least partially, in the groups that tried to employ the systems approach. Some groups did not find the conference a training ground of this kind.

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* This objective was to be met principally by the analysis of the overall conference structure in the published report.

(i) To develop courses or units of courses.

It was quite apparent that the Life Scientists had the toughest task under this objective, while the mini-course groups probably had the easiest work, in the sense that the content could be more easily and quickly defined and the methodology concentrated upon. None of the groups had any chance, in the time available, of completely developing even one unit of a course, and it would have been unrealistic to have expected that. Some made very good progress, however, and are to be congratulated.

The Future

The Open University's experience in course development is not entirely applicable to Ontario conditions, it is true, but my own opinion now is that it would be better for the biologists to proceed cautiously through developing (from the workshops) modules or units as pilot projects. These projects would allow staff to gain more practice and to improve their skills, while at the same time offering all members of the conference some samples with which to persuade their departments that such developmental work is worthwhile.

To propose the development of complete courses at this stage is to propose the deployment - at high risk - of large capital sums and considerable manpower. The risk derives from the traditional university context in which every academic is expected to prove his scholarship by being capable of teaching his subject almost unaided and certainly without somebody else's comprehensive instructional packages. Unless sales can be guaranteed, the high development costs cannot be justified. The complex problems of developing and marketing software for higher education are viewed warily by commercial publishers and we should be no less wary.

Conclusion

In my opinion, the conference was a success. To use a term used at the Briars Inn, we went far beyond motherhood in many of the groups. There were distinct products. And follow-up seems certain.

Such a series of collaborative workshops could not have been organised in the present climate of academic opinion in Britain, and the degree of cooperation between universities represented at the Briars Inn was a revelation to me personally. I hope such cooperation in Ontario will long continue.

I appreciated greatly the relaxed and informal atmosphere that prevailed, and feel I made some good friends and professional colleagues."

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In attempting to expand on Dr. Hawkridge's assessment of the conference we must take into account the extent to which it was a new experience for all concerned. It was above everything else a learning experience not an application of already acquired expertise. This was true for those who originated the idea, for those who planned it, for those who attended it and for those who now attempt to evaluate it.

There will be considerable emphasis in the next pages on error. In order to put this emphasis in proper context, we should say at the outset that from an overall point of view the conference was an unqualified success. Almost all of the delegates worked very hard during the conference and found that it exceeded their expectations as an intellectually stimulating and worthwhile practical exercise.

This is well illustrated by the following quotations from a letter submitted after the conference by one of those who attended.

"No one could come away from Jacksons Point an unchanged person; forced to rethink his whole concept of education and convinced that he could never be the same in the classroom again. In twenty-two years of teaching this was the first time I gave my full attention for a sustained period to thoughts about teaching. While I had given lip service to the vague concept of the systems approach I had never really come to grips with it. The whole experience was indeed profound.

"... they congealed into a solid working unit, and felt they were accomplishing something really worthwhile."

Yet, there was some dissatisfaction that certain things could not be covered and it is not unfair to suggest that the conference demanded too much of the delegates and that it attempted to do too much. We have already described the origins of the conference as the result of the collective concern of biologists about problems of first year teaching in combination with a CUA-COU interest in testing the possibilities of inter-university cooperation in preparing and sharing common instructional materials.

The conference as it developed from these two thrusts attempted therefore to combine:

1. A training phase in which the objective was to teach the systems approach.

2. An operational phase in which the participants were expected to work together towards the solution of a particular task in curriculum development.

3. A consideration of the possibility of advantages of cooperating the production of instructional materials.

4. An informal exchange of ideas and experiences.

Too Much Expected of Delegates?

Clearly in planning the conference the formal program concentrated on the training and operational phases. The implicit assumption was that, given a selection of materials to read in advance followed by an introductory lecture from an expert, the academic delegates could then proceed to "learn by doing" in the small workshop groups. It is now obvious that if this basic assumption was to prove correct several conditions would have had to be met.

1. Delegates would be selected for their interest in learning the systems approach and for their temperamental suitability for group work.

2. The introductory material sent to each delegate would be designed for easy study and comprehension.

3. Delegates would "do their homework" on the material received.

4. The workshop chairmen would in each case be knowledgable and experienced enough themselves with the systems approach to keep their groups working along systematic lines.

5. There would be enough "experts" on the scene to provide special guidance to any group which lost its way and was beyond the help of its chairman.

For a clientele already inclined towards cooperative activities, the basic assumption was reasonable. But, as the experience of the conference showed, the supporting conditions were not fully provided for. Delegates were not in all cases chosen soon enough to have time for necessary study. Nor were

they in all cases chosen with careful regard for their likely compatability with the assignment. Selection was left to each university and while the overall success of the conference attests to delegates well chosen on the whole, there were no doubt a few cases where choices were made perfunctorily or for irrelevant reasons.

Was Advance Material Adequate?

The material sent out for advance study was the best that could be put together in the short time available. From the benefit of hindsight it is clear, as Dr. Hawkridge pointed out, that the MacKenzie book is an excellent intermediate text in the systems method but an inadequate introduction for persons coming to it for the first time. The Creet diagrams and accompanying text eliminated some ambiguities from the MacKenzie presentation but still demanded more careful study than most readers were prepared to give. It is clear that some simple presentation of the basic concepts is required if individuals are going to teach themselves the basis of the systems approach.

No doubt the level of written materials distributed before the conference was partly responsible for the inadequate preparation of most delegates. Few had done their homework to the extent which they would have required from students as a matter of course. A number of obvious excuses, end of term, pressure of examination marking, etc. can be made. The fact remains that, in this instance, few delegates, selected for their interest in teaching, found time for enough preparatory study before the conference.

Training of Chairmen

The crucial role of the workshop group chairman was recognized by the planning committee. As things turned out, the one and a half days spent in training chairmen a month before the conference, while better than no training at all, was not enough. The difficulties faced by individual chairmen were compounded in some cases by lack of preparation by delegates. Those chairmen who were most successful had already had some experience with course teams or comparable approaches to curriculum, or had persons with such experience in their groups. But there is no doubt that more time should have been devoted to training chairmen and that the pretraining sessions might have been used to weed out the one or two who had been mistakenly chosen for the role.

Role of the Experts

The degree of success achieved overall, depended heavily on the good fortune of the planning committee in securing their first choices among the very short list of "experts" available. Messrs. Hawkridge and Dowdswell in particular contributed, each from his own unique experience, immeasurably to the growth of understanding of delegates. Others, especially Dr. Southin and Dr. Frank Mercer from Indiana, made vital contributions to the success of the conference. It is probable, however, that groups would have achieved more uniform success if each had had an expert consultant attached to it throughout. In a real life course development situation such a consultant is part of the necessary apparatus and it is probably not fair to saddle the group chairman with this responsibility in addition to his other chores. The problem is that experienced consultants are in short supply and we cannot hope to continue to bring them from England or the United States every time they are needed.

Other Factors

The shortcomings listed above contributed to the unevenness of results of the workshop groups. The size of the groups themselves was more appropriate to the teaching/learning function than to the operational function. The operational function of the conference would have been more satisfactorily served by smaller groups in a university setting where library and audiovisual facilities would have been available. In the event, since the learning function was predominant there is little doubt that the relatively isolated resort exclusively occupied by the conference was ideal.

A few other aspects of the planning and preparation of the conference require comment. Each participant was asked to submit a brief position paper on some aspect of the instructional process of particular interest to him or to her. There were several purposes behind this request. Preparing such a paper would ensure some involvement of each delegate before the conference began. The variety of viewpoints and interests presented in the papers would provide chairmen with background on their members and would stimulate responses from the conference membership generally. While these purposes were in fact served, the position papers might have contributed more directly to the central objectives of the conference if the assignment had been made more specific and related specifically to study of the preparatory material.

Most of the time of the conference was spent in the small workshop groups. The original program provided time at least once a day for semi-plenary sessions in which groups working on the same problem would come together to compare notes. This schedule was not rigidly followed because it was frequently clear that such semi-plenaries would simply prove distracting for groups who were making good progress by themselves.

In general, the nuts and bolts of the program fitted together well and the structure and planning of the conference was judged by most to be satisfactory. The overall time - about four full days - was long for some groups. Generally the excess of time was in inverse proportion to the success of the groups in getting into the systems method proper. Those groups which got involved in the systems approach found the time all too short. But even for these it was an intensive effort and there was unquestionable fatigue and staling toward the end.

It will be clear from what has been said above that the delegates were a heterogeneous group with varied individual objectives. Talking to them during and after the conference, there was a very strong indication that each had obtained something valuable. Perhaps the diffuse and multiple objectives of the whole conference helped in this respect. The total benefit may indeed have been higher than from a much more structured conference with more limited and clear-cut objectives.

While the outcomes of the conference for individuals were various and cannot be measured in any satisfactory way, it is important to see whether there are any general conclusions which can be drawn from the collective experience. These can be considered under three broad headings:

1. Implications for university teaching generally

2. Implications for teaching biology

3. Implications for inter-university cooperation.

Implications for university teaching generally

In the preface we asked the question "do most university teachers need help in recognizing and meeting the problems of teaching?". The answer to this must be an unequivocal "yes". Even the most experienced and widely read of

the delegates to the TUBS Conference found new ideas and useful criticisms of old ideas. Moreover, the session demonstrated that few of the teachers were able to establish concisely any reasonable concordance between their objectives as originally stated and those served by the study program proposed. If we accept that clear enunciation of objectives is necessary in teaching (both to prevent the inclusion of unnecessary or trivial material and to make clear to the student why the material presented is relevant) then it is clear that formulation of such objectives and their clear communication to students is essentially a new discipline for most university teachers. Moreover, it is not a discipline which is quickly learned or easily applied as several of the guest speakers pointed out.

This is not to suggest that the TUBS Conference was anything like a perfect model for providing learning opportunities in teaching for university faculty members. Nevertheless, the conference demonstrated that there are substantial numbers of faculty eager to learn under the guidance of recognized experts. We shall return to ways of extending such learning opportunities in the concluding part of this section.

Implications for teaching biology

Biology is currently of high interest to students for two reasons. There is a relatively new and intellectually exciting development of theoretical biology in what has been primarily a subject approached through observation and inference. There is also a pressing need for ecology - for a study of man's role in nature.

Biology is therefore in a phase of rapid change in public interest, in emphasis, and in approach. It is becoming necessary to teach it to increasing numbers of people inside and outside the universities. Because there is such a vast amount of descriptive material, and because the theory is not yet developed to a point where a whole university program must be structured in a hierarchical sequence, there is wide opportunity for whims and prejudices to dictate what is taught and how. Put in the reverse way, biology is a subject which has a great deal to gain from a systems approach - from asking perpetually why one should teach this or that - as well as how one should teach it. Because there is a great deal of visual, written, and experimental material, a mix of approaches and methods involving library, laboratory, and field work and utilizing a wide range of media is desirable.

The conference provided for the biology teachers in Ontario universities a much greater understanding than there was before of what is involved in a redesign of courses and curriculum and in the systems method. This cannot but help to accelerate the evolution of teaching programs which will be better adapted to current needs. But how fast and in exactly what ways this will happen are not yet clear.

Implications for inter-university cooperation

Do the economics of scale, implicit in full-fledged application of the systems approach, inevitably require inter-university cooperation in course development and preparation of instructional materials?

To answer this question we must first consider the general one of how to make the best use of the teaching resources in a university system. This can be answered in part by asking what is the most effective way of organizing the teaching of a large first year class of 1000 students. It is clear from the earlier reports of the groups at TUBS that this resolves itself into two questions: how does one get the best instructional materials and how does one get the most effective student-teacher contact?

One solution which is put forward seriously by many is to reduce class size. Now this is in essence antagonistic to at least one aspect of the cooperative production of teaching materials which requires economies of scale. It is therefore essential to look at the implications of these two approaches.

Teaching effort can be divided into the two categories of "preparation and presentation" and "direct student-teacher contact". Preparation and presentation refers to such activities as study before writing or otherwise preparing teaching materials, the actual drafting or organizing of these and their presentation to the student. The student is not involved in any of these activities except in small classes in which presentation and student-teacher contact become mixed. Student-teacher contact refers to any situation in which the teacher is able to follow the mental processes of the skill development of an individual student and can provide a direct critical feedback. It is essentially a one-to-one relationship but it must be clear that it need not be restricted to interviewing one student at a time. The small seminar group of 6-8 students is based on this kind of relationship.

It is difficult at present to say just how effort is divided between these two categories of teaching but the

magnitude of the figures does not materially effect the analysis. We can agree, however, that more time could be profitably spent on student-teacher contact.

Let us take a specific case. If we have a class of 1000 taking a first year course and we want small classes, we can split the class into 20 sections of 50 each and assign each section to a professor. If we consider that each of these sections puts in two hours lecture and a three hour laboratory per week we shall have allocated 100 hours of teacher effort to the 20 sections. But, because a lecture takes more hours of preparation per contact hour, this might more appropriately be thought of as 140 hours (4 hrs preparation and presentation for the lecture and a 3 hr lab).

If we assume that the lecture provides almost no effective man-to-man contact, but that in a three hour lab the teacher gets one hour of effective contact with members of the class, this would give us an overall pattern of 120 hours of preparation and presentation and 20 hours of student contact or a 6:1 ratio in favor of preparation and presentation.

Suppose we rejected this small class plan and put everyone into one class, assigning our three best teachers entirely to preparation and presentation. This would give us 21 units of preparation and presentation which would be a threefold increase. Since the three best are working together it is likely to represent at least a fivefold effective increase and we have left approximately 120 units for direct contact - a sixfold increase.

This analysis suggests that a revision of our teaching procedure along more logical and systematic lines is needed at the departmental level. From the work done at the TUBS conference, however, it is clear that the three-fold increase in preparation time would hardly begin to achieve the kind of improvements in course design and teaching materials which those who participated in TUBS would like to see.

The answer to our question then is that the notion of system and the notion of cooperation can be separated. Any professor working individually on a single course for half a dozen students may be able to improve that course and the cooperation between himself and his students by working out a clearer rationale for the whole course and each component in it. However, this will be a minor application of the method with minor results for the system. The place where systematic development is most needed is in very large classes where involvement of the student with his instructors is the least. For such courses it is possible to get a partial benefit from

the systems approach within one department. But, when the allocation of time for preparation and presentation on the one hand and for faculty/student contact on the other is carefully considered, one is driven to argue that a fully systematic approach will have to go beyond the department and utilize the collective resources of a group of universities.

We should not be frightened by the spectre of uniformity which is conjured up whenever serious proposals for cooperation are made. It can be convincingly argued that the main pressures towards uniformity are external to the universities themselves. Pressures for easy transferrability of credits, requirements of professional training programs, patterns of finance, etc. exist whether formal cooperation aimed at actually improving the quality of instruction is undertaken or not. It can be further argued that this kind of cooperation can provide the instructor with time to work much more closely with students in their individual approaches to the objectives of the course in question. Because of added demands on his time in relation to the general affairs of the university, the efforts of the average university teacher have been increasingly fragmented in recent years. While he may not yet recognize it, his personal stake in developing a systematic and cooperative approach is very high because it offers real savings in time - particularly in large first and second level courses. At the conference there was little reluctance to consider radical approaches involving cooperative design, development and use of common materials and there was at least partial recognition of the potential advantages to university teachers in a cooperative approach.

The possible implications of the systems approach go far beyond matters discussed at the TUBS Conference. Some of these extended implications are developed by one of the editors in a postscript to this report. In the final part of this section we recommend particular actions which flow more or less directly from the conference.

Recommendations

The TUBS Conference illustrated that learning enough about a systematic approach to course development and teaching to improve individual performance is a time consuming process even for the most dedicated professor. It also illustrated that experienced experts are indispensible contributors to the learning process. They are also indispensible to the operational phase of actual course development whether on a relatively small scale in a single institution or on a larger multi-institutional basis.

Therefore, if the quality of instruction in our universities is to be improved, two fundamental conditions must be met:

1. Professors must find, or be found, time in which to study principles of course design and instructional methods.

2. Expert, experienced instructors must be available to assist and encourage such study.

In helping the universities of Ontario to meet these conditions we think that the Centre for Instructional Development proposed in the report Television and Technology in University Teaching can play a central role. We believe that the centre, as soon as it is established should give first and equal priority,

a) to the development of a package of instructional materials designed to acquaint university professors with all available methods for improving university teaching including the principles of the systems approach.

b) to the development and training of at least twenty course consultants needed to provide expert guidance in teaching and applying the systems approach without continued reliance on limited numbers of experts outside of the Ontario system.

Part (a) is, in effect, a proposal that outright funding be found for the development of a "module" of instruction in teaching methods at the university level. Such a module might be prepared in cooperation with universities elsewhere but its specifics should be close enough to Ontario's experience to be useful here without substantial adaptation.

Part (b) could be approached in several ways. It is clear that study of university teaching is as intellectually demanding and as exciting as any other field of scholarly activity in the university. It will not be beyond the imagination of individual universities to offer sabbatical and other leaves for purposes of concentration on such studies. However, in view of the policy of the Canada Council to withhold grants from those with purely educational interests, it will be necessary to find a substantial amount - perhaps $75,000 per year - administered in a flexible fashion to support those who wish to use extended leave to become "experts" of the sort described in this report.

These fundamental programs are essential to positive results in the long run. In the shorter run, the Centre for Instructional Development should, of course, assist in the design of ad hoc instructional programs designed to improve university teaching.

We would also recommend that funds be made available to assist other groups interested in arranging special conferences for the purpose of exploring inter-university cooperation in a discipline. While the TUBS model is not appropriate unless a high degree of cooperative momentum already exists, it is a cost-effective technique when compared with alternative forms of teacher training.*

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* The cost of the conference involving nearly a week's training for 100 university staff at various stages of their teaching careers can be compared approximately in total time and money invested, to the cost of putting four persons through a year of teachers' college. The grant made by the joint COU-CUA committee provided for a sum not to exceed $6000.00 for organization, honoraria and travel of invited speakers and publication of a report. The participating universities paid the travel and maintenance costs of their delegates which amounted to about $125.00 each. This gave a total cost for the conference of a little under $20,000.00. Because this conference was for experienced teachers deeply involved in teaching, and because it involved a very intensive training, it is judged by the editors to have been more cost effective than any plan for an extended and formal training is likely to be.

POSTSCRIPT

Pursuing the Objectives of Independent Study

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Chairman, TUBS Conference

The TUBS Conference was not about the Open University concept nor applications of aspects of it to Ontario. But, because the Conference was about a systematic examination of teaching objectives and strategies for reaching them, and because the course development program of the Open University was the basis for Dr. Hawkridge's keynote address and served as a prototype for the workshop sessions, it provided a clear invitation to review degree programmes as well as courses in a more systematic and less campus-centred way. This invitation was even stronger for those who had an opportunity to talk with Dr. Mercer of MacQuarrie University (currently at Purdue) and to read the copy of his paper on experiments which MacQuarrie had done on courses offered externally or on campus by techniques applicable to external offerings.*

The effect of all these influences had led to the proposal which follows. In its simplest terms, it is a proposal that every university graduate should do a portion of his degree work in courses which require him to be highly independent of regular classroom experiences. Because of this independence, courses developed for offering in this way can be done inside or outside the university. There is no implication in this suggestion that students now receive too

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* Heather Adamson and Frank Mercer. The Impact of External Teaching in Traditional Approaches to the Teaching of Biology at Macquarie University. The Australian University, Vol. 8, No. 2. 1970.

much assistance. Rather the argument is that what they get should not be dissipated in bits and pieces throughout their courses but should be concentrated in some courses to give the students real assistance and virtually eliminated in others to help them develop independence. It is a proposal having to do with a redeployment of teacher effort rather than a change in amount which is another question.

It has, however, large educational and financial implications. If a component of the degree program involves courses carefully developed for independent work then these courses must be much more appropriate to either current extramural programs or to an institution such as that proposed for Ontario by Trotter*. Indeed, the proposals in this section might be looked at as possible modifiers of his proposal rather than as providing a complete alternative.

The proposal can be made clearer by developing the argument in support of it. The argument which follows is intended to clarify and to justify further study but does not attempt to be exhaustive. Indeed, the proposal is put forward at this time tentatively since it clearly would require very careful examination before its feasability could be established.

We may I think accept as legitimate, if only partial, the following objectives for any university system.

1. To provide an educational experience which is permanent. Permanence in this sense has two important aspects. The first is simply that what is learned is remembered. The second and more important aspect is that the students develop habits of independent study which will result in more, and more critical, reading throughout their lifetimes. Permanence in this sense provides for replenishing, refurbishing, updating and increasing knowledge.

2. To provide a versatile scheme in which students in quite different circumstances can adapt their educational program to these circumstances. Diversity, or at least the potentially for diversity, is implicit in such versatility.

3. To provide a range of opportunities which are, nevertheless, of uniformly high quality.

4. To keep costs as low as is consistent with quality. That is to keep cost effectiveness as high as possible. This objective has two aspects. One is the desirability of keeping the total cost to society at a reasonable level. The other is to keep costs as low as

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* Bernard Trotter. Television and Technology in University Teaching. Committee of University Affairs and Committee of Presidents of Ontario Universities, Toronto, 1970.

possible for each component of the University's work so that funds are available for research, or study leave, or any of the important activities which might be curtailed in periods of economic stringency. The politician and the professor have comparable, if dissimilar, reasons for seeking economies in university operations.

5. To develop a more elastic system so that increased student enrolments need not always imply a linear increase in capital investment in university plant.

6. To improve teaching. This may, in the light of the preceding report, require a major input of resources. There has been a great deal of "fiddling" and minor experimentation over the past few decades. But, there is some evidence that improvement in university teaching requires a radical re-thinking. There is in effect an energy barrier and until we can apply enough effort to broach this we shall make little progress.

Of these objectives, the first is of pre-eminent importance. One of the most serious charges which can be levelled at university teaching and at student evaluation and certification is that both stress information or technical achievement at a time which is so close to the time of first learning that the information, knowledge or skill may be transient. It is true that there is increasing attention to behavioral objectives which might lead to continued independent study and perhaps to steadily increasing rather than to only temporary understanding but this seems still too little to be generally effective.

The two bases for continued study are interest and self confidence. Self confidence comes from demonstrated success. It is therefore essential that students learn to do independent work and under conditions which convince them, as well as their teachers, that they can "go it alone".

Independent study can come in a variety of forms from the occasional essay or laboratory project to a degree done largely at arms' length from the teachers through an organization like the Open University or like one of the many extramural systems found in America. The educational value of independent work is recognized but the optimum organizational pattern is not clear. Most extramural programs have not been particularly successful. If we accept the values of independent study we must develop better ways of encouraging it.

In this connection the following viewpoints are at least arguable. In outlining these viewpoints I have referred to first, second and advanced level courses. These perhaps need a word of explanation though they represent essentially the levels used by the Open University and those referred to in many writings on curriculum. A first level course is offered to those entering university, or beginning study of that subject. Regardless of secondary school prerequisites, it must begin very near the beginning. A second level course can assume a first level course. A third level course is defined here as an advanced one, essentially at the frontiers of knowledge in that subject. Formal course work should not have to go beyond this level.

1. Direct and effective student-teacher interaction is an essential part of a university education. A whole degree program done external to a university is therefore likely to be bad. One which is begun externally is likely to be inefficient.

2. The student who enters university is not yet ready for completely independent work. It follows that a first year student will not profit much from an independent program. Each student needs at least a full year - perhaps three terms - of instruction aimed at developing him as an apprentice scholar able to work on his own before trying to work independently. During these terms he would, of course, also be getting a good deal of information and technique. A student who had served a two or three term apprenticeship to university study might then be asked to take any other first level courses needed to fill out his background, and most of his second level courses, through an independent study and therefore potentially external, program.

3. A student doing advanced work should have developed a large measure of independence but work at this level requires critical discussion. The role of the teacher in advanced courses is quite different from his role in a first year course but the students are equally dependent upon him. Advanced courses should be done in a university.

4. A student who had both learned and demonstrated his capacity for independence might work more effectively in a system of senior courses which differed significantly from those currently offered. The differences might well result in fewer courses and less time spent in presenting material. The senior courses would attempt to continue the training in independence while at the same time offering ready interchange between student and teacher on the approach to problems with which both were concerned.

5. The effect of the degree programs such as those outlined should be to produce, on average, a graduate who is much more of a scholar than those now coming out of our system. I use the term scholar here simply to describe a person with a taste for study.

The objective of permanence of educational effect has been stressed in this outline because it is an important one to which we are now giving too little attention. The other objectives which were outlined earlier are largely self explanatory but should perhaps at this stage be related briefly to the overall proposal.

Versatility, especially in terms of the individual student, could readily be provided in the scheme suggested. If done outside the university, the second level program could be done in one, two or three years. It could be combined with a job or be a sole occupation. It could be broad or narrow and it could provide for the taking of additional first level courses as background for the senior program decided upon. The essential feature of the courses proposed for this level is not that they must be done externally - only that they are so organized and presented that they may be done without constant association with a teacher or access to the full library and laboratory facilities of a university.

There will be an immediate response to this proposal from representatives from certain disciplines - notably the sciences - that an external program is quite impossible for their subject. This has been the traditional viewpoint. It was mine until I saw something of the preparation of courses for the Open University and later heard from Dr. Mercer of the tests they had run in Australia. Drs. Adamson and Mercer reported on their work as follows:

> "The advantages which external students derive from off-campus practical work as a result of the development of kits and study guides are also available to internal students. After one year's experience with external students, kits were also issued to internal students in the introductory biology courses at MacQuarrie University. This was not without problems, but in general the trial run was successful. Our experience confirmed our hope that internal students would profit and enjoy the opportunity to pursue some practical aspects of biology as a private study activity. It also allowed us to see clearly the difficulties as-

> sociated with modifying traditional course structures in biology within a conventional university framework.
>
> We are convinced that by issuing kits and study guides it is possible for students to follow an investigatory approach in an introductory biology course, even given the limitations imposed by the traditional timetabling of science courses. However, there are other ways of organizing biology courses involving independent investigation. We envisage, and to a limited extent even now operate on, an Open Laboratory approach for internal students."

Both the courses of the Open University and the MacQuarrie course could be considered "first runs". The feasibility of external courses will certainly be judged to some extent on their successes and failures but should be judged even more on the degree of success of the Mark II and Mark III external courses which will be developed from the prototypes now available. What appears now to be quite clear from the successes some of these courses have had is that we have been far too conservative and unimaginative in our views about what could be done by the university but not necessarily in the university. Indeed in Canada we have tended to make available externally not the best we could offer but the worst.

The uniformity of opportunity in the system proposed here arises from the fact that all university students would be expected to do part of their work in the university of their choice but all could also be expected to do some outside. This prevents development of "U" and "semi-U" groups which is inherent in many of the systems now being discussed or developed.

The cost advantages of the proposed system cannot be estimated until it is worked out in much greater detail. The number of students likely to be involved in such a program in Ontario alone would be sufficient to justify the very large investment of time required for the preparation of first class course materials (which at second level would need to provide pre-tests, remedial material, and exceedingly good evaluations to assure that an honest second level attainment was reached). But because the scale of operations would be very large there could also be a large net saving.

An added saving worth pointing out is that such a scheme would, as indicated above, almost certainly reduce the numbers of courses offered, both in the early years and at the senior levels, thus reducing redundancy which is at present a costly and wasteful factor in university programs.

The potential elasticity of this system is not quite as great as the Open University or the general degrees institution proposed by Trotter. It does, however, introduce a large measure of elasticity within departments, within the university, and most of all within the provincial system. This elasticity could be greatly increased if it were possible to take a degree based on first and second level courses only with perhaps some third level courses available externally. Since general degrees are in any case made up largely of first and second level courses, there would be little if any sacrifice in quality if many of the general degree students continued externally and took a degree with only the first year in residence.

The possible improvement in teaching which might arise from such a system, especially if it were operating in close association with the work being done in more traditional university programs, is considerable. If the conclusions from the TUBS conference are correct and a critical systematic development of teaching materials can pay off but requires a very large amount of effort to launch properly, then a system which provides a rationale for these large development costs will have to be found before the approach can be taken.

The development of some elastic system of offering university education outside the universities appears to be needed. Similarly, the redeployment of teaching time in the university seems badly needed if effort is to be used efficiently. The proposal which is made here for an integrated internal-external approach offers such a system while also meeting certain important educational objectives. It merits critical evaluation.

APPENDIX I -

TUBS CONFERENCE DELEGATES

Brock University

A. W. Bown (Biology)
A. P. Cottrell (Biology)
B. M. Millman (Biology)
M. Nwagwu (Biology)
D. J. Ursino (Biology)

Carleton University

B. T. Deutsch (Biology)
M. B. Fenton (Biology)
R. Grey (Biology

University of Guelph

W. C. Allan (Entom-Apiculture)
J. A. Carpenter (Microbiology)
N. A. Epps (Microbiology)
G. Hofstra (Botany)
H. Lerer (Entom-Apiculture)
L. Lowe-Jinde (Zoology)
H. Lue-Kim (Botany)
W. E. Rauser (Botany)
J. B. Sprague (Zoology)
G. G. Stott (Biomedical Sci.)

Lakehead University

W. M. Graham (Biology)
D. R. Lindsay (Biology)
J. P. Ryder (Biology)

Laurentian University

H. Falter (Chemistry)
J. W. Green (Biology)
T. Naylor (Biology)
W. Y. Watson (Biology)
K. Winterhalder (Biology)

McMaster University

L. A. Branda (Biochemistry)
T. Dickinson (Microbiology)
J.E.M. Westermann (Biology)
W. Pallie (Anatomy)
G. J. Sorger (Biology)

University of Ottawa

J. B. Armstrong (Biology)
D. Erskine (Geography)
J. C. Fenwick (Biology)
G. A. Kinson (Physiology)
O. N. LaHam (Biology)
B. Sparkes (Biology)
J. Vaillancourt (Biology)

Queen's University

F. Cooke (Biology)
D. T. Dennis (Biology)
J. Gordon (Biology)
C. H. Hood (Biology)
S. S. Lazier (Civil Engin.)
P. H. Platenius (Psychology)
D. G. Sinclair (Physiology)

Trent University

D. B. Carlisle (Biology)
R. L. Edwards (Biology)
R. Jones (Biology)
T. R. Matthews (Biology)
K. Murtrie (Biology)
A. Worthington (Psychology)

University of Toronto

H. L. Atwood (Zoology)
C. S. Churcher (Zoology)
J. E. Cruise (Botany)
N. G. Dengler (Botany)
W. G. Friend (Zoology)
J. W. Grear (Botany)
V. Higgins (Botany)
J. B. Jones (Chemistry)
G. E. Macdonald (Psychology)
I. Tallan (Zoology)

Erindale College (Toronto)

P. J. Pointing (Zoology)
G. R. Thaler (Botany)

Scarborough College (Toronto)

M. Filosa (Biology)
J. C. Ritchie (Biology)
F. Urquhart (Biology)

University of Waterloo

G. H. Downer (Biology)
H. R. Eydt (Biology)
R. H. Wakefield (Biology)

Waterloo Lutheran University

D. A. MacLulich (Biology)

University of Western Ontario

H. J. Battle (Zoology)
W. Bohaychuck (Plant Science)
J. A. George (Zoology)
R. C. Jancey (Plant Science)
P. F. Mercer (Physiology)
D. G. Wilson (Plant Science)

University of Windsor

R. J. Doyle (Biology)
J. E. Habowsky (Biology)
F. James (Biology)
D. des S. Thomas (Biology)
D. G. Wallen (Biology)
G. Winner (Biology)

York University

E. Beet (Biology)
S. V. Filseth (Chemistry)
C. D. Fowles (Biology)
B. G. Loughton (Biology)
S. Madras (Chemistry)
E. R. Nestermann (Biology)
D. Schiff (Biology)

Other Delegates and Guests

W. R. Chan (University of the West Indies, Mona, Jamaica)

L. V. Davis (Commission on Undergraduate Education in the Biological Sciences)

R. Harmsen (Ontario Confederation of University Faculty Associations)

B. B. Lazier (QTV, Queen's University)

J. B. Macdonald (Council of Ontario Universities)

F. Mercer (Biological Sciences, Purdue University, Indiana)

D. L. C. Miller (Ontario Educational Communications Authority)

W. A. Young (New Learning Media Division, Association of Universities and Colleges of Canada)

Conference Staff

Mrs. Jeri Harmsen (Co-ordinator)

Mr. Mario Creet (Consultant)

Mrs. Ginny Arnold (Secretary)

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Miss Louise Smith (Secretary)

Mr. Neil Carter (Graphics)

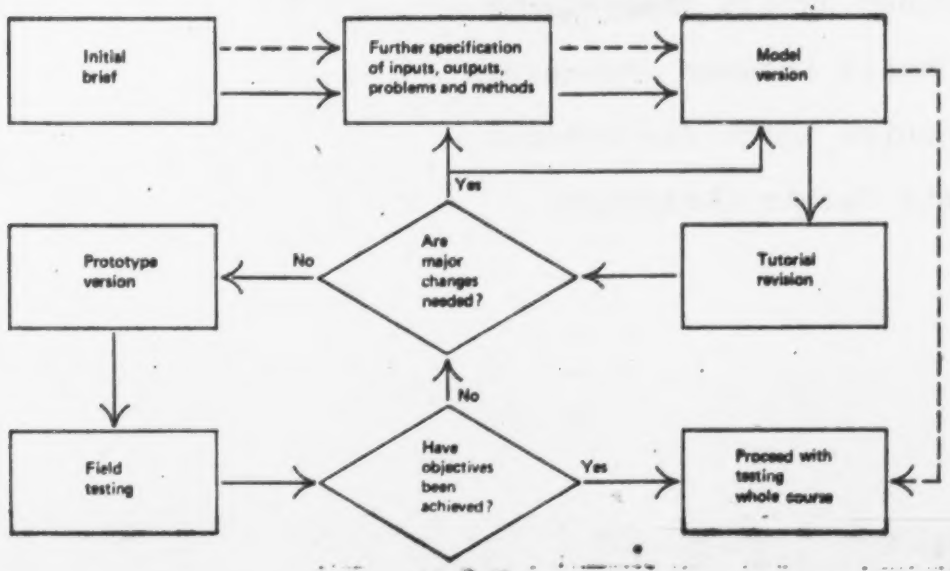
APPENDIX II - A GENERAL SYSTEM FOR COURSE DEVELOPMENT
(A Supplement to Chapter XI of Teaching and Learning)

Mario Creet, Office of Academic Planning, Queen's

This scheme is intended to provide a framework for discussion of Chapter XI of Teaching and Learning by N. MacKenzie, M. Eraut and H. C. Jones. The 'system' identified by MacKenzie et al. is not defined or developed sufficiently to be a practical basis for developing a course. It is hoped that the graphic system depicted here may become a bridge for translating the ideas in the text of Chapter XI into a working method. The construction and terminology here match the text of Section 3 as nearly as possible if allowance is made for errors in interpretation. Page numbers are from the text of Section 3.

The diagrams on p. 161 (Fig. 3) and p. 164 (Fig. 4) depict processes which are more suited to the development of computer programs than to the exchange and growth of ideas in face-to-face groups, even if systematic (both orderly and of a system) development were seen as a prime requisite of the latter. The yes/no alternatives directed at a computer are predicated on a fixed design which permits reiteration only along paths which have already been traversed. By contrast, the return of a set of ideas to a starting or intermediate point is profitable only if a different and richer traverse will be encountered. Thus, in the clarification of objectives, the starting point is a broad definition of aims. These are given increasing precision as each sequence of the course outline is examined. However, at the end of the sequence, if not at any point before then, the discussion will return to the original aims, will test whether there should be new statements, and then traverse the steps to the end in a modified heirarchy of emphasis. Figure 4 from MacKenzie's text is given below:

SUBSYSTEM DESIGN AND DEVELOPMENT



p. 164

The notes and diagrams that follow are suggested as a substitute for the above scheme. Five main stages are identified, which are:

Preliminary stage:	'clarification of objectives'
Stage I:	'initial brief'
Stage II:	'model version'
Stage III:	'prototype version'
Stage IV:	'whole course'

There are three sketches; the first sketch shows the symbols used to designate the components of the system, the second illustrates the clarification of objectives and the third unites the stages in course design and development.

The clarification of objectives is the preliminary stage in a program of course development. The first stage is preparation of the 'initial brief', for which the inputs are the objectives, the characteristics of teacher and learner, and an outline of the substance of the course. A further input at this stage is the estimate for the development of the course and a notion of its operational cost. The next stages consist of sequential building of the substance (content, method, evaluation) and form (media, logistics) of either a module or the whole course. At each stage the several steps of the process (plan, design, analyse, allocate) are applied, with iteration if necessary. In any case, the whole cycle will need to be traversed at the final stage of development of the whole course. The importance of words and the need for their common definition in the preliminary stage cannot be too highly emphasized.

Two words are used here with a different meaning or emphasis from that of the text. These words are:

'module': the authors use 'subsystem' in a way that is ambiguous, but may mean that portion of a course which is built round one topic or a group of closely-related topics. 'Module' is used here in precisely that sense. The 'system' under development may be either a course or a module. 'Subsystem' may also be used to refer to any coherent slice of the system.

'evaluation': is used in the text interchangeably with assessment, analysis and testing. It is defined on p. 116 "as the assembling and analysis of evidence prior to decision-making". It is used here with the same intention but with the additional restriction of being applied only to learners. 'Analyse' is used here to denote other evaluative steps in the 'process'.

A minimum of explanation is offered as an aid to interpretation of the symbols in the schemes which are intended to be suggestive, and possibly irritant. Each person is invited to attempt a personal construction. First, in the 'clarification of objectives', the teacher and learner each formulate a general set of objectives with teacher and learner in mind (i.e. each as subject operates on each as object). An outline of the course either exists or is formulated (e.g. the main topics of 'biology for everyman' would suffice). The unified initial set of objectives is made progressively more specific in terms of the course content, method and evaluation. The stepwise configuration of the outline suggests a necessary sequence. The position the outline occupies within the figure-eight shape has no significance other than a suggestion that the role of the course outline at this stage is to help clarify the objectives.

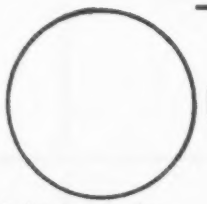
In 'course development' these objectives, the course outline and an outline of material requirements for mounting the course are composed into a first approximation of the intended course for the purpose of preparing the budget for development and a first guess at an operating budget. The output of this stage is the 'initial brief'. Outputs of each stage become part of inputs for the next stage. The roles of outline and objective are reversed: the objectives are now a reference set for detailed preparation of the substance of the course. If the course is being developed by a team, each specialist of the team will interpret and stress certain aspects and stages of the general system in the light of his particular tasks.

A General System For Course Development:

SYMBOLS FOR COMPONENTS OF THE SYSTEM

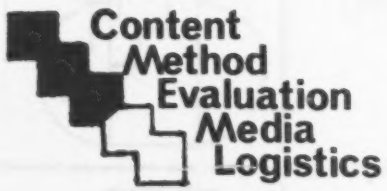
Teacher

Learner



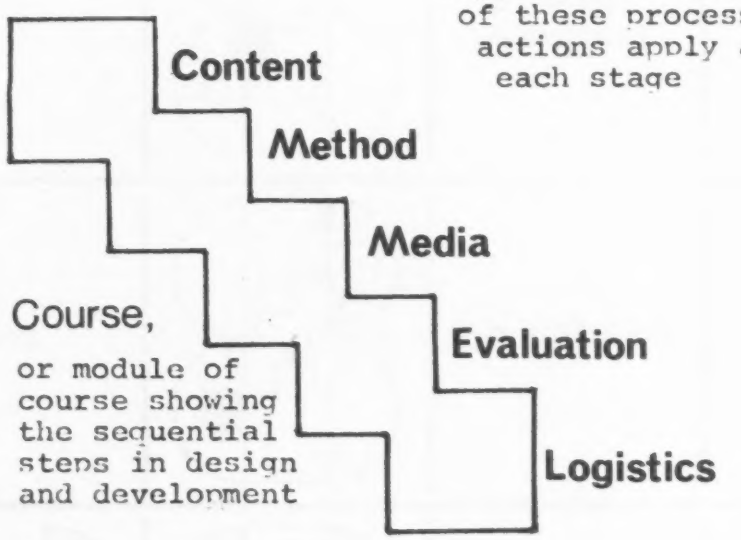
Resources

Materials



Course outline

and emphases during clarification of objectives (Note: the sequence of 'evaluation' and 'media' is reversed when the details of the course are developed)

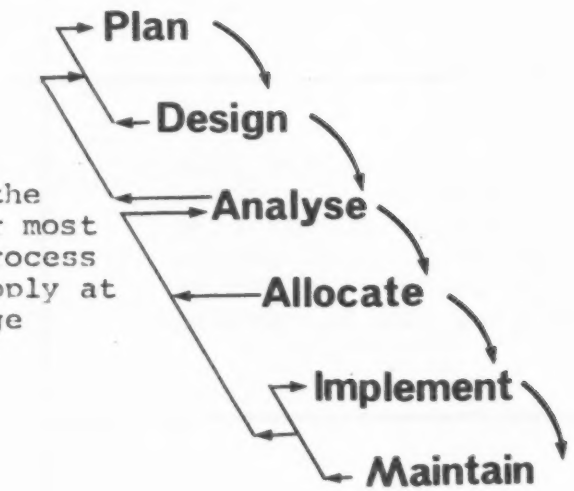


Course,

or module of course showing the sequential steps in design and development

Process

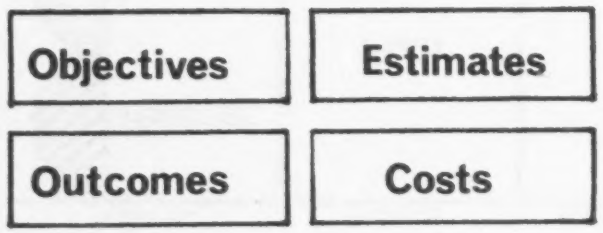
Actions to be taken along the way; some or most of these process actions apply at each stage



Aspects

of each stage of growth of the system; 'Emphasis' is also an input, but one that is either new or particularly stressed

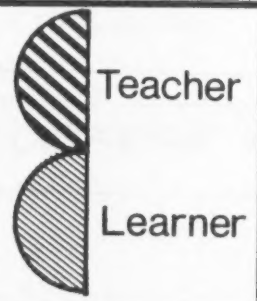
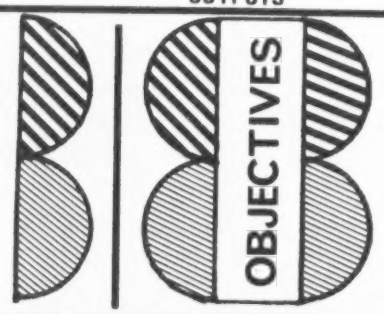
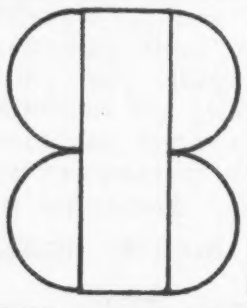
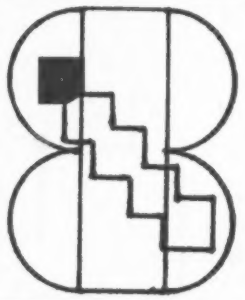
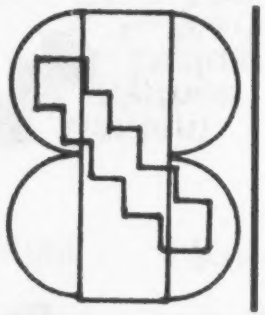
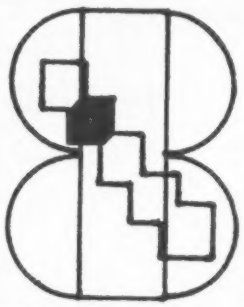
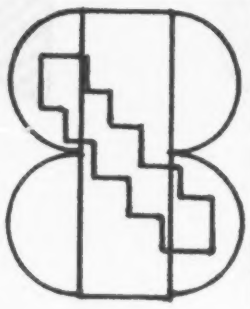
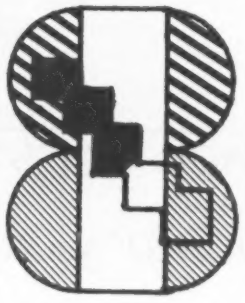
- Inputs
- Process
- Emphasis
- Outputs



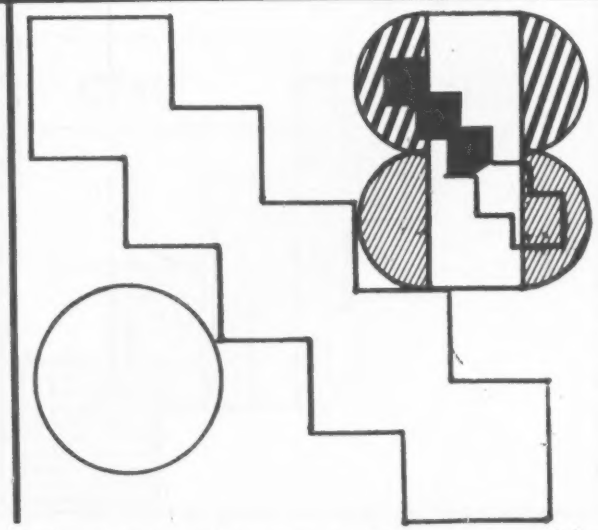
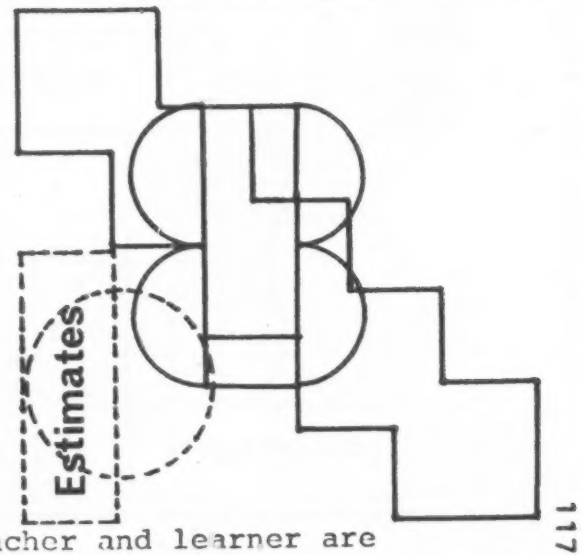
Measures

which help to answer: 'How are we doing?'

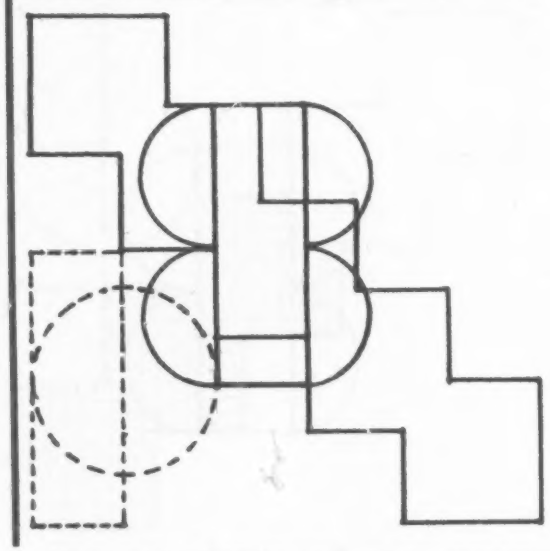
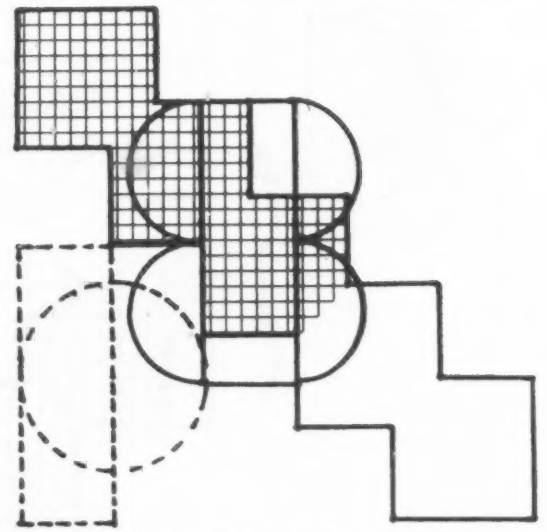
Clarification of Objectives.

INPUTS	PROCESS	EMPHASIS	OUTPUTS	'SCRIVENS' LEVEL	
	**Plan**			**Initial**	Teacher and learner each defines objectives on own behalf and in respect to the other: each as subject operates on each as object.
	**Design**	Content		**Conceptual**	Objectives are expanded in terms of course / module outline with emphasis on content: the main topics of 'biology for everyman' would suffice.
	**Design**	Method		**Manifest-ational**	Objectives are further expanded in terms of method, i.e. what combination of lecture, tutorial, laboratory, self study?
	**Plan** **Design** **Analyse**	Evaluation		**Operational**	Objectives for evaluation are added and the whole set analysed and redefined if necessary. Evaluation here means student testing and assessment.

Course Development

STAGE	INPUTS	PROCESS	EMPHASIS	OUTPUTS
Stage One 'Initial Brief'		Plan	Estimates	

The objectives, a course outline and the characteristics of teacher and learner are combined in a plan for which the costs of development and operation are estimated.

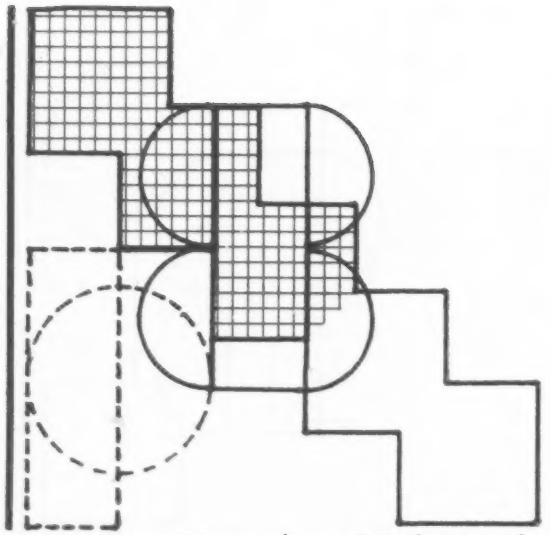
Stage Two 'Model'		Plan → Design → Analyse	Content Method Evaluation	

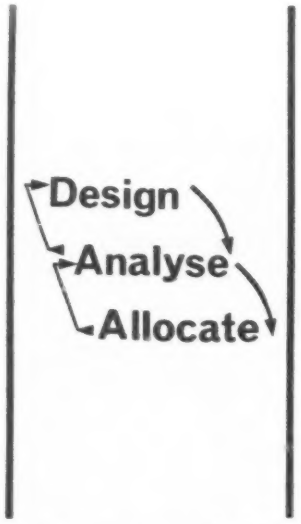
The substance of the course is developed into the 'model'. (Generally, university courses have seldom gone beyond this point).

Course Development (cont'd)

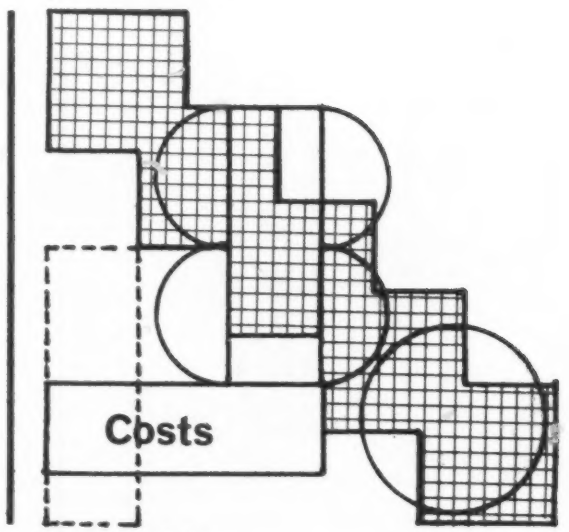
Stage Three

Developed Proto-type





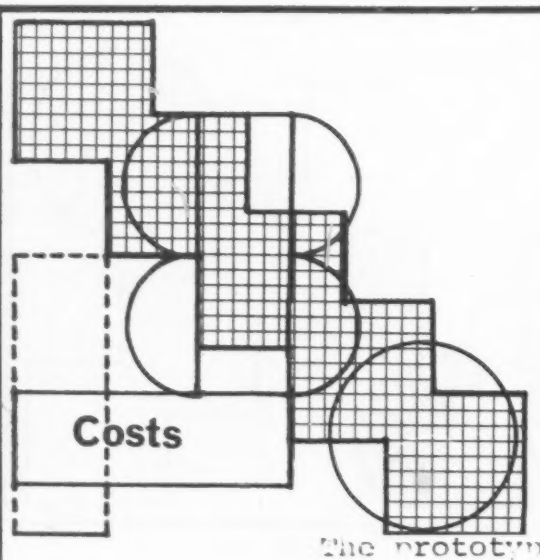
Costs
Media
Logistics



Form is added to the substance and the allocation of operating costs is prepared. When recycled to an optimum, the result is the prototype development.

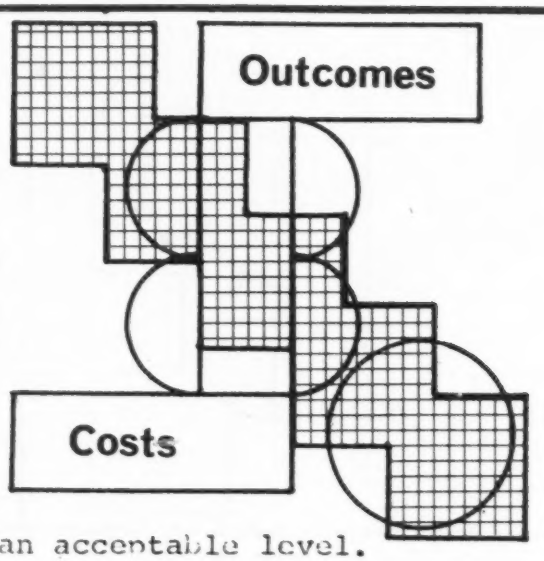
Stage Four

Whole Course or Module



Field test

Outcomes



The prototype is tried out and improved to an acceptable level. If not a disaster, the course is offered on a regular basis.

THEN : **Implement** / **Maintain** *Happily ever after*

APPENDIX III

Detailed outline of the module "Why do ferns grow where they do?", prepared by Group E, Workshop 2, and including time allocations and assignments for each week of the course.

Timetable	Educational process	Staff involvement
One hour early in first week	1. Lecture: - introductory - 2-3 min. film of growing fern - question: What is a fern?	Professor, one contact hour, 5-8 hrs. preparation (perhaps making use of T.V. or lecture in large theatre or given in repeated live sessions.

Develop answer

A	B	C
informational component	classifying component	integrative and exploring components
evidence, could be heavy early in course to make students feel secure	guidance in bringing order into A	ask questions and direct towards information sources → Ref.*

lead towards formulation of problems, and development of desire for relevant information

One hour unscheduled reading time

* Ref.: reference to specialist biological subdisciplines, chemistry, physics, etc.
- black boxes not to be opened at this time.

1 1/2 hr., 1 day appr. after lecture	2. Pre-lab tutorial: Informal get-togethers, where pertinent questions are asked. The desire for an exploration of a fern in its ecosystem is stimulated - direction towards information sources	Professors and tutor-demonstrators with groups of 12-20 students. 1 1/2 hr. contact and 1 1/2 hr. preparation for each professor
3 hrs. or longer (open-ended if possible) soon after tutorial	3. Laboratory 1: A variety of fern specimens, prepared fern material and related material is available. The student is encouraged to ask questions and formulate information out of the data contained in the system. Allow students to apply other disciplines, e.g. geography, geology. Organized questioning, classifying and generalizing should be encouraged. Direction to further information sources, (reading, audiovisual material, etc.)	Professors and tutor-demonstrators with groups of 12-20 students. 3 contact hrs. for each professor. Estim. 6 hrs. preparation per professor
Unscheduled time (3 hrs.?) scheduled in same slot as lecture of previous week (1 hour)	4. Information gathering: a) Reading - in library and/or handouts b) Scheduled audio-visual presentation (e.g. colour film on fern ecology)	No contact. Approx. 3 hrs. preparation for professor
1 1/2 hour - same slot as 2	5. Reflective tutorial: Discussion; mutual criticism and questioning; staff provides props to concentrate discussion; students bring their own selected evidence. Introduce concept of hypothesis and possible experimental data gathering	Professor and tutor-demonstrators with tutorial groups of 12-20. 1 1/2 hr. contact and 1 1/2 hr. preparation for each professor

Three hours or longer - same slot as 3	6. Laboratory 2: A guided lab (sheet provided): organized group experiment. Practice in experimental design and data analysis. Cooperative class effort. Concept of statistics. A laboratory report design is discussed	Professors and tutor-demonstrators with tutorial groups. 3 contact hrs. and 3 hrs. preparation per professor
Unscheduled time	7. Essay: Each student writes a 1000 word essay on the topic of the module which is due at the end of the second week	No staff involvement
	8. Laboratory reports: Each student is supplied with example lab report at end of second week. (In subsequent modules, students prepare their own lab reports).	Tutor-demonstrator - 2 hrs.
One hour (same slot as 1 and 4b)	9. Assessment and feedback: Essays and lab reports are discussed and evaluated	Professors and tutor-demonstrators with tutorial groups. Apprx. 6 hrs. evaluation followed by 1 hr. contact

This constitutes a time involvement of 2 1/2 weeks for the module. The student involvement is 21 hours (11 contact: 10 unscheduled) or approximately 9 hrs/week. For professors the involvement is a total of 35 hours (11 contact: 24 preparation) or approximately 15 hrs/week. The pre-term course development time is 100 hours. For tutor-demonstrators it works out to 25 hrs. (10 contact: 15 preparation) or approximately 10 hrs/week.

It was recognized by the group that a number of 2 1/2 week modules would not in itself make a course. At various intervals the implications of all modules must be integrated. The unifying principles of the biosciences should eventually fall out of the course and the summarizing and integrating process at the end of the course should be very much a responsibility of the students. The actual size, content and approach of each module should change throughout the course as the students mature. An increasing emphasis should be placed on student-originated communication (including report writing, design of experiments, choice of topics) or in other words, less teaching and more learning.